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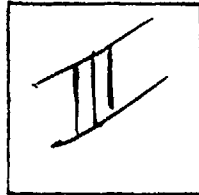
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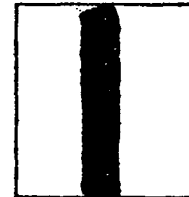
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INVENTORY

A History of the U.S. Army in Operations Research

DOCUMENT IDENTIFICATION

Smith, F. L.,

22 May 67

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A HISTORY OF THE U. S. ARMY IN OPERATIONS RESEARCH,

An abstract for a thesis presented to the Faculty of
the US Army Command and General Staff College in
partial fulfillment of the requirements of the
degree

MASTER OF MILITARY ART AND SCIENCE

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U. S. ARMY COMMAND AND GENERAL STAFF COLLEGE
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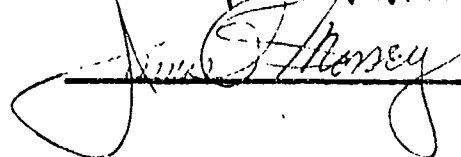
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The opinions and conclusions expressed herein are those of the individual student author and do not necessarily represent the views of either the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

This thesis is an incomplete historical investigation of the scientific method henceforth referred to as "operations research." The purpose of the thesis is to trace the evolution of operations research in the U. S. Army and to provide the military staff officer and decision-maker with an appreciation for the usefulness of the method and the scope of its application to military problem-solving.

Operations research has become a significant tool in the Army's arsenal. Its application in cost-effectiveness studies; development and improvement of weapons, equipment, tactics and strategy; and other operational activities is an accepted fact. Operations research is not new. Its techniques can be traced from the investigations of ancient scientists. Operations research merely combines the normal scientific observations undertaken by any scientist with systematic analysis employing probability and statistical theory to more effectively identify and select one or more alternative courses of action. In itself, operations research does not make decisions--it merely assists the staff-planner and decision-maker in identifying the alternatives and selecting a course of action based upon the stated objective. In order for the military staff-planner and decision-maker to most effectively use this tool, they must understand the purpose of the method, its application, its potential, and its pitfalls.

Operations research was introduced in the United States during the early stages of World War II to assist in overcoming severe deficien-

cies in the research and development programs of the military services. Historically the military services of the U. S. have been reliant upon the nation's civilian inventors and industry to develop and produce new weapons and equipment. Prior to World War II many government sponsored civilian scientific agencies were organized. However, most of these organizations were limited in scope and temporary in nature.

In 1942, the U. S. deployed its first operations research groups with Navy and Army Air Corps elements in the U. S., Europe and the Mediterranean. Later the Office of Scientific Research and Development (OSRD) and the Office of Field Services (OFS) were created to satisfy the requirement for integration of available scientific effort at home and to provide technical support for the field forces. These agencies were the primary U. S. operations research activities of World War II.

The OSRD and OFS were terminated at the end of World War II and the Army retained some of the operations research activities within the technical services. Various means, such as advisory committees, research boards, etc., were used to keep the civilian and military scientific communities working together; but generally speaking, they were only marginally successful. Following the reorganization of the Defense Department in 1948, the Army established its first of many research contract groups, the General Research Office, with the Johns Hopkins University. Since then other groups have been developed to study technical problems; analyze such problems as counterinsurgency, human resources, tactics and strategy; and collect data to support area studies. The Army also continued the expansion of its in-house operations research capability in order to meet the requirements generated by Department of the Army, Army Materiel Command, Combat Developments Command and others.

During FY 67, an operations research/systems analysis program was formally established by the Army. This step was in recognition of the increased importance of operations research within the Army and the Defense Department. The civilian scientific and managerial communities have also seen the tremendous opportunities presented by the proper application of the method. Thus the future of operations research seems to be limited only by the imagination of its analysts and the acceptance they can achieve among the staff-planners and decision-makers. The Army should significantly improve its operations research posture with increased and improved schooling for its junior and field grade officers.

A HISTORY OF THE U. S. ARMY IN OPERATIONS RESEARCH

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U. S. ARMY COMMAND AND GENERAL STAFF COLLEGE
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ACKNOWLEDGEMENTS

To Lieutenant Colonel Frank P. Vellella, my research and thesis monitor, whose understanding, knowledge and assistance were of incalculable value in the planning and preparation of this thesis; to the acquisition and circulation staffs of the Command and General Staff College Library, who furnished the bulk of the material for the thesis; and to my wife, whose quiet patience and support was essential throughout--my gratitude and my thanks.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
LIST OF TABLES	v
LIST OF ILLUSTRATIONS	vi
LIST OF ABBREVIATIONS	vii
INTRODUCTION	1

Chapter	Page
I. EVOLUTION FROM ANTIQUITY	4
II. THE AWAKENING	15
III. CHILD OF WAR	30
IV. EVOLUTION TO MATURITY	47
V. CONTEMPORARY OPERATIONS RESEARCH	68
VI. FORECAST FOR THE FUTURE	97
 BIBLIOGRAPHY	 104

LIST OF TABLES

Table	Page
I. Army In-House Operations Research Groups - 1962	72
II. Percentage Distribution of Topics in ORO Semiannual Reports July 1948 - June 1961, by Subject	84
III. Percentage of US Army OR Effort by Subject and Study Topic	85
IV. Distribution of OR Personnel by Original Discipline . . .	87

LIST OF ILLUSTRATIONS

Figure		Page
1.	Steps in Operations Research Problem-Solving	9
2.	Steps in Operations Research Problem-Solving	0
3.	Evolution of Civilian Support of U. S. Military Research and Development	27
4.	HUMRRO Organization Evolution (1951 - 1959).	60
5.	Operations Research Office Organization 1 April 1954 . .	64
6.	Army Organization for Research and Development 1959 . .	69
7.	U. S. Army Combat Developments Command Organization 1962	77
8.	Army Organization for Research and Development 1 April 1967	102

LIST OF ABBREVIATIONS

Abbreviation

AREB	Army Educational Requirements Board
AFPHRU	Army Field Forces Human Research Unit
AMC	Army Materiel Command
ARO	Army Research Office
ASA	Army Security Agency
ASF	Army Service Forces
ASWORG	Anti-Submarine Warfare Operations Research Group
BERL	British Branch Radiation Laboratory
BRL	Ballistics Research Laboratory
CDC	Combat Developments Command
CDCEC	Combat Developments Command Experimentation Center
CDEC	Combat Development Experimentation Center
CE	Corps of Engineers
C&GSC	Command and General Staff College
CIA	Central Intelligence Agency
CINFAC	Cultural Information Analysis Center
CHLC	Chemical Corps
COA	Comptroller of the Army
CORG	Combat Operations Research Group
CPM	Critical Path Method
CRESS	Center for Research in Social Systems
DCSOPS	Deputy Chief of Staff for Operations
DOD	Department of Defense
GM	Guided Missiles
GRO	General Research Office
HRU	Human Research Unit
HUMRRO	Human Resources Research Office
MC	Medical Corps
NRDC	National Research Defense Committee
OCAFF	Office Chief of Army Field Forces
OEG	Operations Evaluation Office
OFS	Office of Field Services
OR	Operations Research
ORD	Ordnance
ORO	Operations Research Office
ORTAG	Operations Research Technical Advisory Group
OSD	Office of the Secretary of Defense
OSWD	Office of Special Weapons Development
OSRD	Office of Scientific Research and Development
PERT	Program Evaluation Review Technique
PPBS	Planning-Programming-Budgeting System
QM	Quartermaster
RAC	Research Analysis Corporation
RACO	Remote Area Conflict Office
RAD	Research and Development
SA	Systems Analysis
SCADS	Scientific Advisory Service
SIG	Signal
SORO	Special Operations Research Office

Abbreviation

SRI	Stanford Research Institute
SSRI	Social Science Research Institute
STAG	Strategy and Tactics Analysis Group
TAG	Technical Advisory Group
TC	Transportation Corps
USAFPE	United States Army Forces Far East
USAREUR	United States Army Europe
USCONARC	United States Continental Army Command
WESG	Weapons Systems Evaluation Group

INTRODUCTION

Down through the ages, wars have been a major contributing factor to the evolution and development of science and scientific discovery. With the improvement of weapons, wars have become more and more devastating. The involvement of people and resources of the committed nations has become greater with each new conflict. This has created the requirement for more thorough preparation and planning for the use of all resources to achieve the level of industrial and military effort needed to insure victory. In a sense, these conflicts led to the recent identification, integration and formalization of ancient research techniques into a recognized modern scientific method.

Despite the age of these techniques and the recent widespread interest in their use, the method has not been formally defined or entitled. It is known in various scientific circles as "operational research," "operational analysis," "operations research," "systems analysis" or other titles. It has been defined in many ways but the following definition is a reasonably simplified but accurate one:

. . . a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control.¹

Another more detailed and a great deal more complicated definition by E.

S. Quade of the Rand Corporation:

¹P. H. Morse and G. E. Kimball, Methods of Operations Research, (1st ed. rev.: New York: The Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc., 1952), p. 1.

... an analytic study designed to help a decisionmaker identify a preferred choice among possible alternatives. It is characterized by a systematic and rational approach, with assumptions made explicit, objectives and criteria clearly defined, and alternative courses of action compared in the light of their possible consequences. An effort is made to use quantitative methods, but computers are not essential. What is essential is a model that enables expert intuition and judgement to be applied efficiently. The method provides its answers by processes that are accessible to critical examination, capable of duplication by others, and more or less readily modified as new information becomes available.²

This thesis is an incomplete historical investigation of the scientific method henceforth referred to as "operations research." Since its formal identification as a scientific method, operations research has become a significant tool in the process of military problem-solving and decision-making. The value of the method and its contribution to the improvement of weapons, equipment and operations since 1940 has generally been overlooked by members of the Army who were not directly associated with research and development activities. Recently, increased Department of Defense emphasis on cost-effectiveness studies forced the Army to expand its role in operations research. Operations research has proved to be the most effective means of supporting the Army's organization, manpower, equipment and budget requirements. In addition, to keep up with the advances in scientific technology and evolution of military doctrine, the Army has increased its internal use of operations research techniques. This expanded use has resulted in opening new fields of analysis at lower command levels. However, the increased importance and use of operations research within the Army has not been accompanied by a corresponding improvement in the understanding, knowledge and acceptance of operations research by the military staff-

²g. S. Quade, Military Analysis (Santa Monica, Calif.: Rand Corp. Memo RM 4808 PR, November 1965), p. 30.

planner and decision-maker.

The purpose of this thesis is to trace the evolution of operations research in the U. S. Army and to provide the military staff officer and decision-maker with an appreciation for the usefulness of this method and the scope of its application to military problem-solving. Although the thesis will be devoted primarily to an examination of the role of the Army, there will be a significant overlap where other agencies and services have influenced the overall development of the method or substantial coordination and cooperation between agencies and services were involved.

There will be no attempt to depict the technical aspects of operations research. Books and reports, which define the techniques in detail and their implementation in projects, are readily available in research libraries. A partial listing of applicable reports and bibliographies are contained in the bibliography. However, no historical examination of this subject would be complete without imparting a recognition of the primary terms and techniques that make up the method. Chapter I will be used to set the stage historically and scientifically. The remaining chapters will show the evolution of the method by natural progression, i.e., Pre-World War II; World War II and its aftermath; Pre-Korea through the 1950's; and finally the 1960's. Due to the operational nature of the subject, much data is still classified making a fully comprehensive history of the later periods difficult. However, the increasing importance of the method, its widening acceptance and expanded use are readily traceable.

CHAPTER I

EVOLUTION FROM ANTIQUITY

Believe nothing, O monks, merely because you have been told it . . . or because it is traditional, or because you yourselves have imagined it. Do not believe what your teacher tells you merely out of respect for the teacher. But whatsoever, after due examination and analysis, you find to be conducive to the good, the benefit, the welfare of all beings --that doctrine believe and cling to and take it as your guide.

Gautama Buddha¹
(563?-483? B.C.)

It has been said that there is nothing new under the sun--that the only difference is in the way we see and do things. This must be true of operations research because the principles underlying this method have existed in the observations and experiments of scientists for centuries. Their approach to these problems was nothing more than an early version of the present-day problem-solving techniques used in operations research. Examples of the employment of these techniques can be traced back to antiquity. Archimedes, the great Greek mathematician and inventor, used these techniques in the development of new devices and procedures during the siege of Syracuse (215-212 B.C.).²

An examination of the conclusions reached by these ancient scientists reveals that they had problems in correctly analyzing,

¹George Seldes (ed.), The Great Quotations (Lyle Stuart, N.Y.: A Caesar-Stuart Book, 1960), p. 125.

²Lynn H. Rumbaugh, A Look at US Army Operations Research--Past and Present (Washington, D.C.: Research Analysis Corp., RAC-TP-102, April 1964), p. 4.

correlating and applying the data obtained from their observations. For example, during the early development of guns, data was obtained concerning the amount of powder used, the size and type of projectile fired and the thickness of the barrel employed to insure safety. But when these observations and data obtained from small caliber weapons were applied directly to the problem of developing larger guns, the results were quite unsatisfactory and very inefficient.³

Two of the more effective early proponents of operations research techniques during the 16th century were Tartaglia and Galileo. They concentrated their efforts on examining the characteristics of exterior ballistics. In the process, they developed the first effective artillery tables and evolved better methods of aiming and employing artillery. In the 17th century Vauban was one of the first to employ a really systematic approach to the problems of the day. He studied the overall tactical and strategic influences of defensive design and methods of attack of prepared fortifications. His analysis emphasized the technical military aspects of the weapons and procedures being investigated.⁴

Leonardo da Vinci is probably the most well known scientist and inventor who consistently recognized and espoused the techniques of operations research. His inventiveness encompassed almost every field of scientific investigation. Included was the development of devices, weapons, procedures and tactics. Da Vinci based his ideas on sound

³Henry M. Wilkinson, Engines of War (London: Longman, Orme, Brown, Green and Longman, 1841), p. 71.

⁴General Research Office, General Research Office Quarterly Report, Vol. 1, No. 1 (Washington, D.C.: General Research Office, The Johns Hopkins University, 30 September 1948), p. 6.

mathematical principle and insisted on verification by experience.⁵

The recognition of the applicability of scientific research techniques to fields other than weapons development was continued in the later examination of the roles of land power (by Clausewitz), sea power (by Mahan), and air power (by Douhet).⁶ Thus we can see that through the years the increased application of the techniques of this scientific method has been a dynamic force in research and development. The continued emphasis on development of its procedures have broadened the scope of operations research and made it more relevant in its application to the many varied activities, interests and responsibilities of the modern-day military planner and decision-maker.

Having introduced the term operations research, it is necessary to define it. In a purely military sense, we can say that operations research is ". . . the application of scientific qualitative and quantitative analysis to the study of warfare with the objective of improving the weapons, tactics, strategy and logistics of the future."⁷ The difference between operations research of today and scientific investigation of the past is that operations research employs specific scientific methodology in its approach to problem solving. This means that when a problem has been identified, the analyst must carefully define and formulate valid assumptions to properly limit the scope of the investigation, logically develop a model to represent the problem within the limiting assumptions, and finally analyze and interpret the conclusions or alterna-

⁵Ibid., pp. 6-8.

⁶Ibid.

⁷Ibid., p. 6.

tives. Operations which lend themselves most satisfactorily to analysis are those which tend to have repetitive features that can be reduced to quantitative representation.⁸

The techniques of this scientific method are resolvable to a series of steps which are basically identical in the analysis of all operations research problems. One analyst's approach to formalizing these steps and a definition of each for clarification is given below:

- 1) Formulation - Clarifying, defining and limiting the problem to something which can be handled.
- 2) Search - Finding, determining and correlating the relevant data and developing alternatives.
- 3) Explanation - Building a model and exploring its consequences.
- 4) Interpretation - Deriving the conclusion or conclusions.
- 5) Verification - Testing the conclusion by experiment.⁹

This particular list of steps is shown schematically in Figure 1. Another example of the steps used in operations research is shown in Figure 2. These schematics are nothing more than a demonstration of the integrated and systematic approach taken by the analysts in solving their problems. These steps clearly tie together the various techniques used in early day research and development and take advantage of modern knowledge and technical improvements.

The heart of operations research is the model. A model is developed by the use of basic mathematical equations to represent the activity, situation, or item under consideration. The most important tool

⁸Raoul J. Freeman, Developments For Modern Management (Santa Monica, Calif.: Rand Corp., Memo P-3210, August 1965), pp. 2-3.

⁹E. S. Quade, Military Systems Analysis (Santa Monica, Calif.: Rand Corp., Memo. RM 3452, January 1963), pp. 6-11.

available to the analyst in the development of his model is probability and statistical theory. This tool has equal application in both operational and experimental problems. With a properly constructed model, it is possible during an analysis to hold some data constant and vary other elements. This makes it possible to almost simultaneously investigate different aspects of the same problem, which under actual field conditions may not be feasible due to the expense or any number of valid reasons. Thus, with a model developed from a few analytical observations or experiments, it is possible to mathematically project a conclusion or series of alternatives for the problem under consideration.

Experts in the field of operations research have identified eight classic operations research problems:

- 1) Sequencing - Determining the order in which specific operations should be accomplished for best results. Two sequencing systems that have been developed and are widely used in the Army are: CPM (Critical Path Method) and PERT (Periodic Evaluation and Review Technique).
- 2) Routing - The process of planning the utilization of time and resources to most efficiently accomplish a series of separate but related objectives. An application of this could be scheduling a courier or developing a plan for maintenance contact team or IG inspection team visits.
- 3) Inventory - Mathematically examining inventory requirements to insure adequate stockage to meet consumer demand for a minimum inventory investment.
- 4) Allocation - Optimizing the allocation of critical items or resources to satisfy requirements.
- 5) Waiting Line - Identifying bottlenecks in an operation, analyzing

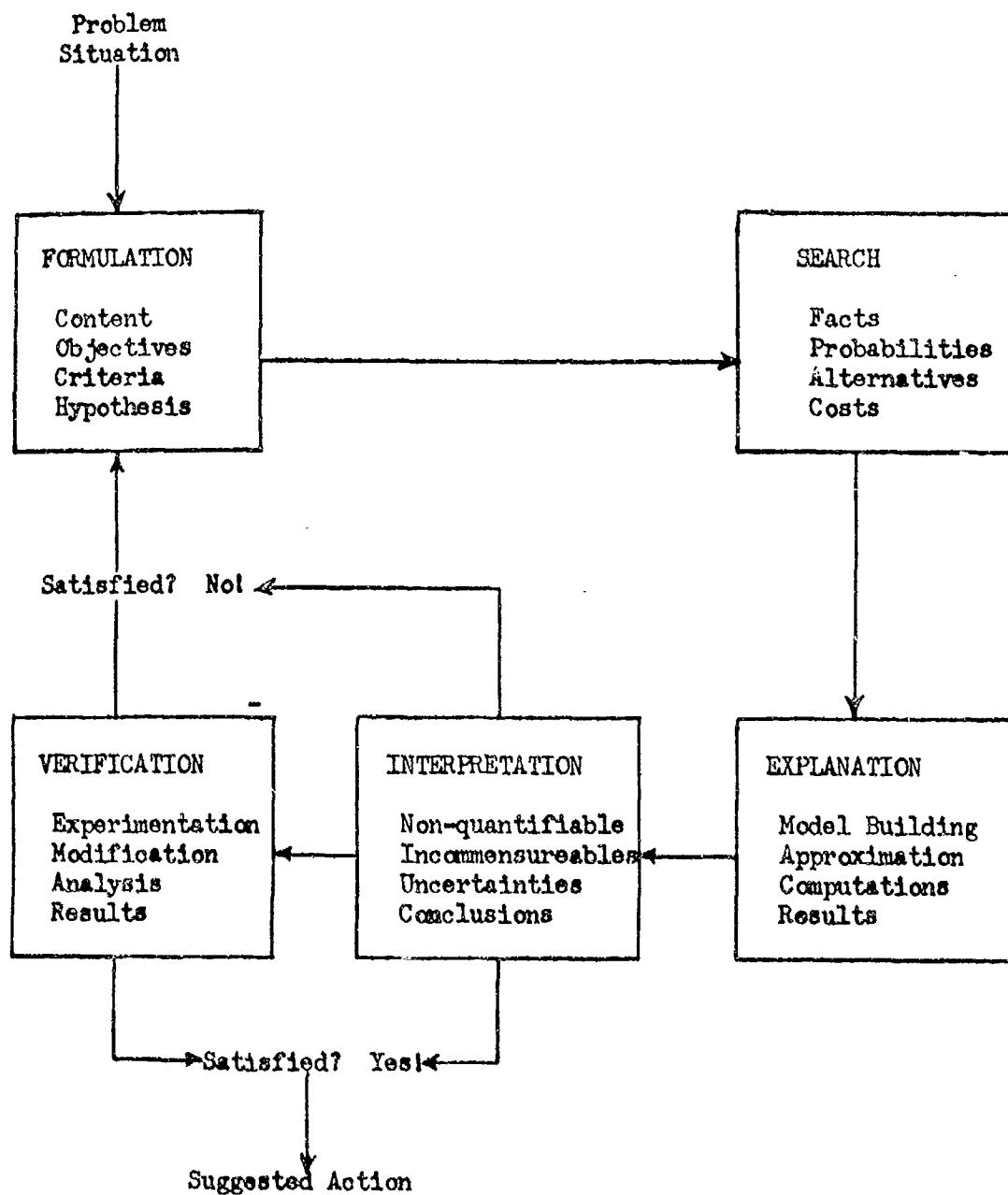


FIGURE 1

Steps in Operations Research Problem-Solving¹⁰¹⁰Ibid.

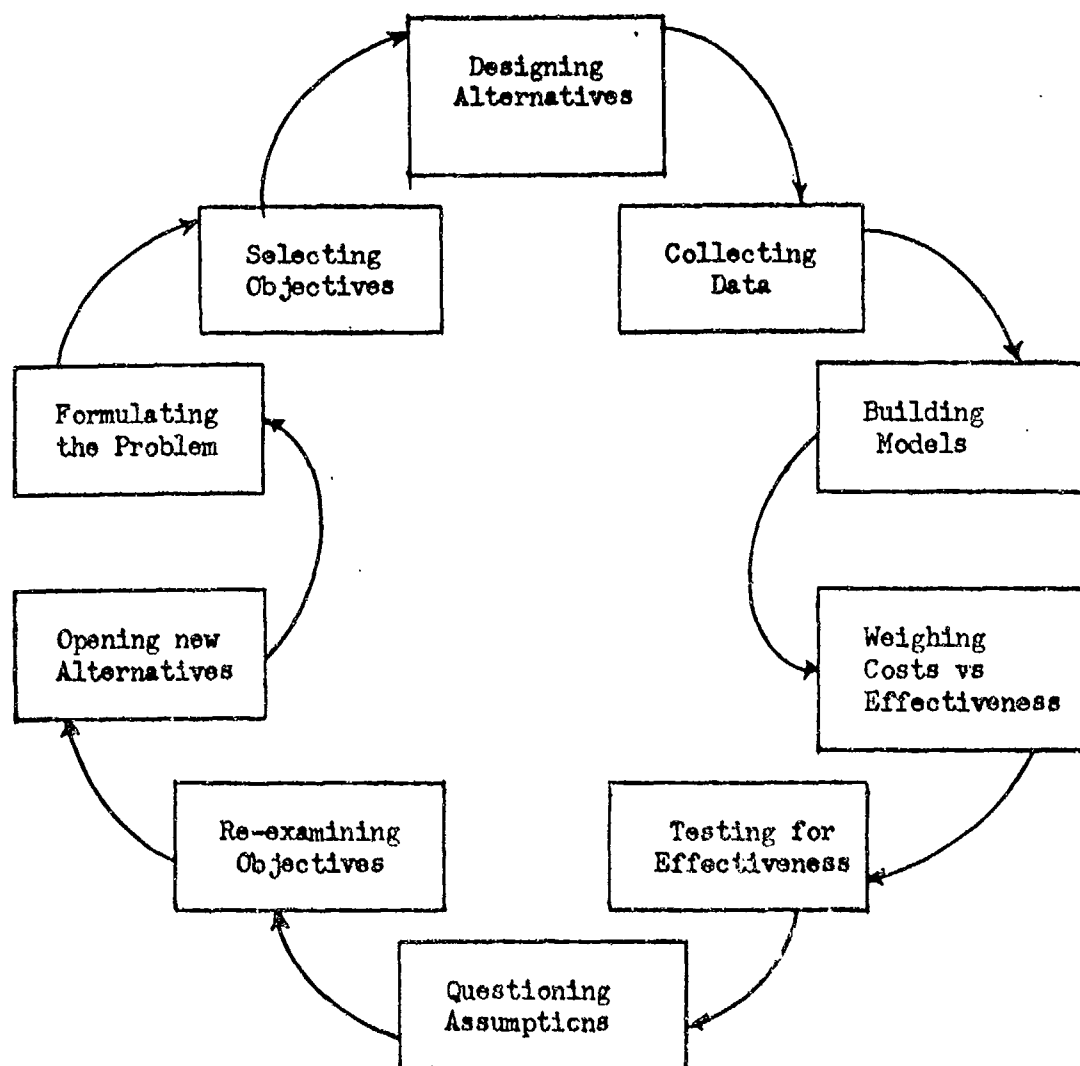


FIGURE 2

Steps in Operations Research Problem-Solving¹¹

¹¹E. S. Quade, Military Analysis (Santa Monica, Calif.: Rand Corp., Memo RM 4808 FR, November 1965), p. 19.

these bottlenecks and developing corrective solutions.

6) Replacement - Developing a plan or schedule to phase out antiquated equipment and introduce replacement items with minimum disruption to the operation and still maintain or improve effectiveness.

7) Information Collection - Identifying the type and applicability of available information and information gathering sources in order to integrate and maximize the effectiveness of the collection plan.

8) Competitive - A situation in which the various alternatives available to two opposing or competitive activities are analyzed to determine the comparative results that are obtained from the opposing alternatives. The results provide a basis for selection of a best or optimum alternative.¹²

It should be recognized that any scientific technique or method contains pitfalls and operations research is no exception. Analysts have identified ten most common pitfalls; they are:

1) Modelism - Being more interested in constructing the model than in insuring that the model is still applicable to the original problem.

2) Statistical Uncertainty - Overemphasizing the probability aspects of an analysis. This tends to consume available time and money while not adding significantly to the solution of the problem.

3) Real Uncertainty - These are the unanswerable questions like when will the enemy attack, in what strength and from what direction. There are naturally many different combinations and limiting these possibilities to insure their validity is a difficult problem.

¹²General Research Office, General Research Office Quarterly Report, Vol. 1, No. 1 (Washington, D.C.: General Research Office, The Johns Hopkins University, 30 September 1948), p. 9.

4) Enemy Reaction - To accurately predict the enemy's reaction to our action is naturally very difficult, but the analyst must be very careful not to go too far into the measure, countermeasure, counter-countermeasure, etc.

5) Over-concentration - Adopting an overly narrow view point or assuming away the difficult parts of the problem.

6) Phasing - Failing to balance yesterday's situation with the requirements of tomorrow to insure the optimum condition for today. In a purely military context this may apply to the timing required to properly introduce a new piece of military equipment before the equipment it is to replace is obsolete.

7) Over-Ambition - Expanding a problem area to the point that it becomes too large to effectively manage.

8) Fanaticism - Adhering too closely to an internal organization party line. Failing to maintain an open mind and unbiased approach.

9) Hermitism - This occurs when the analyst creates a wall of misunderstanding or distrust by his failure to communicate with the project originator. Often this is best illustrated by the overly technical reports that the analyst prepares, which the non-technical person does not readily understand.

10) Butch - An arithmetic error or mistaken technical notion or fact.¹³

In addition to the pitfalls mentioned above, there are two "procedural fallacies" recognized by analysts in operations research. The first of these is "Authorititus" which is simply failure to properly identify and define the problem, establish the criteria which the analysis

¹³Herman Kahn and Irwin Mann, Ten Common Pitfalls (Santa Monica, Calif.: Rand Corp., RM 1937, 17 July 1957), pp. 1-52.

is to satisfy, and limit the scope of the study. If these items are left strictly to the analyst, it is doubtful that the study will prove to be completely valid. In order to prevent this from occurring, the originator should make his expertise available to the analyst at all stages of the analysis. This will offset the disadvantage of the analyst normally knowing little or nothing about the area of his investigation prior to commencing his analysis.¹⁴ The second fallacy is identified as "Vacuumitis," which is being too selective during data collection. Data collection is a necessary element of operations research; but it is possible to limit this collection to those items which will support a preconceived conclusion. These preconceptions may be the analyst's or he may be influenced by some other person or agency. In any event this fallacy, if permitted to enter a study, will result in conclusions which are invalid or of limited value.

Thus we see that what is new about operations research is its recognition as a scientific method with the resulting identification and formalization of the various techniques employed in its utilization. As technology increases in scope and magnitude, the demand for technological advances multiply the problems of research. There are many ways of accomplishing research but the correct application of the techniques of operations research will assist the researcher and decision-maker to more easily define the best sequence or sequences to pursue in his investigation. Thus it is apparent that operations research is devoted to the understanding and characterizations of the operations or the systems under analysis. However, in order to be really effective, the analysis

¹⁴Bernard O. Koopman, "Fallacies in Operations Research," Operations Research, August 1956.

must go more than surface deep. Modern scientific analyses provide possible solutions to problems; but these solutions are only as practical and feasible as the people who define the problems, state the objectives and choose the criteria. The analyst and the individual who initiated the requirement must beware of the common pitfalls and fallacies and carefully avoid them in order to achieve effective results in operations research.

CHAPTER II

THE AWAKENING

(Generals),¹ extolled for standing still,
Or doing nothing with a deal of skill.

William Cowper²
(1731-1800)

To understand the importance that operations research has played in United States Army research and development, it is necessary to consider the impact of U. S. civilian science and foreign scientific activity on these programs. It is also necessary to examine the Army's posture, attitude and activity in research and development prior to World War II. Historically the armed forces of this country have been reliant upon the nation's civilian inventors and industry to conceive and develop improved equipment. Despite this fact, new ideas and equipment have not been readily accepted and adopted by the armed forces. However, an even more critical problem has been achieving and maintaining a readiness posture in peacetime that will support the nation's requirements in a future conflict.

United States efforts to integrate civilian research and development resources into the national defense structure have been primarily based upon the criticality of the existent defense situation. In times of peace the expenditure of time, effort and money has been limited. In

¹Author's substitution--exact quotation reads "Admirals."

²The Oxford Dictionary of Quotations (2d ed., London: Oxford University Press, 1955), p. 162.

wartime the emergency steps taken to overcome the slack developed during the years of peace has been wasteful in time, money and manpower. For successful pursuit of the war this slack must be quickly overcome. Throughout the peaks and valleys of the research and development effort, the civilian segment successfully maintained its autonomy and academic freedom from the dominance and restrictions of the military. The reason for this adamant attitude by the civilian scientists has been their belief that the inertia of the military and restrictions of its chain of command tended to stifle creative thought.³ Despite these problems, a very successful military-civilian research and development program has evolved over the years. As technology and the complexity of warfare and equipment increase, the desire and ability of the scientific community to meet these new challenges improve.

The Civil War was the occasion for the first formal integration of the military and civilians in the fields of research and development. To bring to bear, quickly and effectively, the available civilian scientific and engineering strength of the North, Congress directed the creation of the National Academy of Sciences on 3 March 1863. This academy was composed of distinguished scientists and engineers from the fields of mathematics, astronomy, physics, engineering, chemistry, geology, paleontology, botany, bacteriology, zoology, anatomy, physiology, biochemistry, pathology, anthropology and psychology. Admission to this distinguished body was through election by the general membership. Congress initially limited the size of the academy to fifty members but by

³Irvin Stewart, Organizing Scientific Research for War (Boston: Little, Brown and Co., 1948), p. 1-4.

the beginning of World War II the size had increased to over 300 members.⁴ The National Academy of Sciences contributed significantly to the development of combat and combat support items which influenced military and civilian activities world-wide.

In 1884, Congress recognized the necessity for developing a centralized planning system for ordnance acquisitions. It directed the formation of a Gun Foundry Board to be made up of six Army and Navy officers under the chairmanship of Rear Admiral E. Simpson. The purpose of the board was to investigate the relative merits of available navy yards and army arsenals for possible conversion to making "modern" heavy ordnance. The board visited England, France and Germany where they collected data on the government operated foundries with their centralized research, development and production of armaments. After collecting this data the board returned to the United States to compare the situation in this country. Upon completion of their analysis, the board recommended the development of two gun factories, one Army and one Navy. They emphasized the need for centralized planning by the Army and the Navy. The board also recommended that private enterprise should be encouraged to work closely with the services and establish supporting foundries.⁵ Thus we can see a recognition and continuation of the close cooperation between the U. S. military and civilian community to provide the industrial strength and scientific talent to meet national emergencies.

In 1916, due to the ever-expanding scientific effort in support

⁴Ibid., pp. 3-6.

⁵Report of the Gun Foundry Board--1884 (Washington, D.C.: Government Printing Office, 1884), pp. 5-8, 46-50.

of war preparations, the National Research Council was created within the framework of the National Academy of Sciences. This council was developed to insure the most effective coordination of civilian scientific effort to support military requirements. Due to its usefulness during the war, this council was made a permanent body to the National Academy of Sciences by Executive Order No. 2859 dated 11 May 1918. At this time the council was sub-divided into divisions which operated in the fields of foreign relations, educational relations, physical sciences, engineering and industrial research, chemistry and chemical technology, geology and geography, medical sciences, biology and agriculture, anthropology and psychology.⁶ As an adjunct to the council and in an effort to continue the close relationship developed between ordnance and private industry during the war, an ordnance-industry coordination team was formed following World War I. By Spring 1940, more than 1100 men were engaged in National Research Council work.⁷

The Ordnance Technical Committee was organized in 1919, to assist in coordinating service requirements. Its specific purpose was to provide a forum where research and development projects under consideration could be discussed, military characteristics determined and implementing action jointly approved by the interested services.⁸

Despite these progressive beginnings, the effectiveness of the research and development program conducted by the Army between World War

⁶Stewart, pp. 4-6.

⁷US Army Ordnance Department, Sketches of the Ordnance Research and Development in World War II (Aberdeen, Md.: Aberdeen Proving Ground, 25 February 1947), p. 9.

⁸G. M. Barnes, MG, USA(Ret), Weapons of World War II (New York: D. Van Nostrand Co., Inc., 1947), p. 6.

I and World War II was generally lacking in scope and depth. The condition of U. S. Army research and development during this period is well illustrated in the comments of Brigadier General G. F. Doriot of the Quartermaster Corps.

It has been said too often that the Army started this war with the equipment with which it had ended World War I. Actually the situation was much worse. Many items which had been developed as the result of field experience in the mud and rain of northern France in 1917 and 1918 were "modified" in peacetime to be more suitable for the garrison life at Fort Benning, Georgia, or Fort Sam Houston, Texas. Even after the outbreak of the war, the importance of improving immediately the existing equipment was not recognized by many. . . . Furthermore, many of the items which are procured by the QM Corps are commercial types. In peacetime research had to be carried out on Ordnance material because there were no commercial types. On the other hand, it was felt by many that the QM Corps could and would accept standard commercial designs and items without difficulty. No single point of view has perhaps done the Army more harm than this one. There are extremely few commercial items which are suitable for military use. The demands which the Army places upon equipment are such that the use of commercial items results in lower efficiency, higher casualties, and incidentally higher costs. The inadequacies of existing equipment and the dangers implicit in its use were brought out at once in the snow and mud of supposedly tropical Africa and in the early campaigns in the Aleutians.⁹

From these comments we can see that prior to and during most of World War II very little emphasis was placed on critically analyzing military requirements. This attitude resulted in placing reliance on time consuming trial and error solutions with extensive subsequent correction and modification of the equipment. Before the war, due to the strict limitations on research and development funds, most procurement was for items of commercial design. This material was not specifically designed for its adaptability to meet wartime requirements. During this period

⁹Erna Risch, United States Army in World War II, The Technical Services, Quartermaster Corps: Organization, Supply and Services, Vol. I (Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1953), pp. 55-56.

research and development in the Quartermaster Corps was under the Director of the Military Planning Division. The other technical services maintained their own in-house research and development activities.

In the build-up period before the war, old surplus items were issued instead of new ones because new ones had not been developed. The War Department's austerity program and policy of leaving most of the research and development effort to civilian industry resulted in only nine percent of the research and development funds requested by the technical services in the six years preceeding the war remaining in the budget when it reached Congress for approval. The limited research and development activity conducted by the Army was not integrated or well planned resulting in poor performance and inefficiency.¹⁰

Although the U. S. research and development effort was in difficulty, we were not alone. In 1939, the British discovered many of the same faults in their own research and development activities. The British identified a definite requirement for the accomplishment of scientific studies by personnel, who were outside normal military authority and its chain of command. The government recognized that field commanders did not have the time nor the detachment to objectively examine their own operations in a truly scientific manner. Due to external pressures to accomplish assigned missions, the commanders tried to make do with what they had rather than take the time, effort and risk to initiate changes. In addition, British scientists felt that the military profession was too channelized and parochial to be able to properly observe and collect the necessary data to devise appropriate corrective

¹⁰Ibid., p. 55.

changes. In other words, these scientists and government officials believed that the military was too close to the problem and literally could not see the forest for the trees.¹¹

On 3 September 1939, at eleven o'clock in the morning, the first identifiable operations research group reported for duty with the Royal Air Force Fighter Command. This group consisted of four men--a physicist, a communications engineer, a mathematician, and the leader who was a radio engineer. These men were civilian scientists who had been borrowed from a government research laboratory. The critical problem of improving aircraft interception procedures and techniques was immediately assigned to the group.¹²

In 1940, Professor P. M. S. Blackett, advisor to the British Royal Antiaircraft Command, founded within that command a formal operations research group. Its area of study was confined to determining how to use radar at the antiaircraft sites.¹³ When this newly developed device was initially deployed to the antiaircraft sites, the developing scientists were asked to advise on its proper employment. There was no time for trial and error solutions with the Battle of Britain raging. By the use of analysis the scientists were able to recommend the most effective antenna locations and how to interpret the radar signals. The results of these precise mathematical and physical studies doubled the

¹¹General Research Office, General Research Office Quarterly Report, Vol. 1, No. 1 (Washington, D.C.: General Research Office, The Johns Hopkins University, 30 September 1948), pp. 6-9.

¹²Craig M. Mooney, "Operational Research a Deciding Military Science," Canadian Business, July 1954.

¹³L. R. Thiesmeyer and J. E. Burchard, Combat Scientists (Boston: Little, Brown and Co., 1947), p. 25; GRO, GRO Report, Vol. 1, No. 1, pp. 6-9.

effectiveness of the whole air defense system.¹⁴ Not only were the antiaircraft gun defenses improved but early warning and intercept procedures were also revamped to provide a much more responsive and effective utilization of available aircraft.

The technological and scientific efforts of these two operations research groups in support of the Royal Air Force and the Royal Antiaircraft Command materially assisted in inflicting a decisive defeat on the German Luftwaffe during the Battle of Britain. During the first two weeks of their attack the Luftwaffe lost over 600 planes to Britain's 259. By the 7th of September, with the commencement of the London Blitz, 1000 German planes had been lost. By the time the assault ended in October, the Germans had lost over 1700 aircraft to Britain's 900.¹⁵ These results were sufficiently important to impress British government and military leaders of the validity of operations research and led to the assignment of operations research groups into other areas of interest. The ultimate result was that British civilian scientists served with their armed forces in every operational theater.¹⁶

Meanwhile in the United States, recognizing the need for better utilization of the available civilian inventive and scientific talent of this country, the President established the National Defense Research Committee in June 1940.¹⁷ This committee consisted of leading civilian

¹⁴Don K. Price, Government and Science (New York: New York University Press, 1954), p. 126.

¹⁵Mooney.

¹⁶GRO, GRO Report, Vol. 1, No. 1, pp. 6-9.

¹⁷US War Department, Logistics in World War II--Final Report of the Army Service Forces (Washington, D.C.: A Report to the Under Secretary of War and the Chief of Staff by Director of Supply, Service and Procurement Division, War Department General Staff, 10 November 1947), pp. 1-9.

scientists headed by Dr. Vannevar Bush, electrical engineer and President of the Carnegie Institution of Washington. Other members of the committee were: Rear Admiral Harold G. Bowen; Conway Peyton Coe, Commissioner of Patents, attorney; Dr. Karl Taylor Compton, President of MIT, physicist; James Bryant Conant, President of Harvard University, chemist; Frank Baldwin Jewett, President of the National Academy of Sciences and President of the Bell Telephone Laboratories, electrical engineer; Brigadier General George V. Strong (later replaced by Brigadier General R. C. Moore); Richard Chace Tolman, Professor of Physical Chemistry and Mathematical Physics, California Institute of Technology, physicist.¹⁸ The first Army liaison officer to this organization was Major General Gladeon M. Barnes of the Ordnance Department.¹⁹

The purpose of the National Defense Research Committee (NDRC) was to focus more of the latent scientific talent of the nation on military requirements--especially that scientific talent available in the nation's educational institutions.²⁰ This committee would provide necessary scientific support during mobilization; generate possible and feasible weapons systems, equipment, etc.; and render scientific advice to the military on the selection and employment of these items. To accomplish this support the committee was sub-divided into divisions:

Division A - Armor and Ordnance

Division B - Bombs, Fuels, Gases and Chemicals

Division C - Communication and Transportation

¹⁸Stewart, pp. 12-14.

¹⁹C. M. Green, Harry C. Thomson and Peter C. Roots, United States Army in World War II, The Technical Services, The Ordnance Department: Planning Munitions for War (Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1955), p. 226.

²⁰Barnes, pp. 6-11.

Division D - Detection, Controls and Instruments

Division E - Patents and Inventions²¹

The NDRC operated primarily through contracts with universities and other research agencies.²² Upon its establishment the committee was assigned eighteen projects in the field of ammunition research. Later the NDRC was made responsible for most of the basic and long range research for military hardware. The unfettered research climate of this organization encouraged the widest application of scientific knowledge in problem-solving.²³

Following the formation of the NDRC, the Army in-house research and development agencies generally restricted their efforts to technical research. The fields of basic and long range research were left to the civilians. Only in the field of ballistics was the Army free to pursue all aspects of research. After 1940 the civilian scientists undertook ballistics research. This left Ordnance primarily in the business of design and development.²⁴

In July 1940, a non-resident body of eminent scientists was appointed to advise the Ballistics Research Laboratory (ERL) of the Ordnance Department at Aberdeen, Maryland. This laboratory was headed by Colonel Hermann H. Zornig. The group of civilian physicists and chemists was entitled the Scientific Advisory Council and was made up of the following scientists: Oswald Veblen of the Institute for Advanced Study

²¹Stewart, pp. 12-14.

²²Ibid.

²³Green, et al., p. 218.

²⁴Ibid., p. 219.

at Princeton, Edwin Hubble of the Mount Wilson Observatory, Thomas H. Johnson of the Bartol Foundation, Joseph E. Moyer of Columbia University, Edward J. McShane of the University of Virginia, David L. Webster of Leland Stanford and others. The council undertook basic research for the Ballistics Laboratory. The Scientific Advisory Council proved to be a very valuable organization throughout the war and was responsible for many important scientific discoveries.²⁵

In the fall of 1940, at the request of the Ordnance Department, twenty-nine district groups were organized to support the various ordnance activities around the country. The district groups functioned primarily as engineering advisory committees for a particular type of ordnance--tank, gun-forging, automotive, etc. Initially these groups were to be only temporary in nature, however, due to their success, they were maintained throughout the war at the request of the civilian war industry. The role of the committees eventually evolved from technical engineering advice to industrial integration committees. This change was caused by a change in emphasis from engineering problems to production problems.²⁶

In March 1941 following the signing of the Lend Lease Act, immediate steps were taken to exchange technical and industrial information with the British. At the same time extensive inter-nation development planning was being conducted by the U. S. and Great Britain. The National Research Development Committee established a branch office in London. In April the British Central Scientific Office was opened in

²⁵Ibid., p. 226.

²⁶Ibid., pp. 231-232.

Washington, D.C., under a distinguished British physicist. In May a Special Observer Group was sent to London to study British military and manufacturing establishments.²⁷

The Office of Scientific Research and Development (OSRD) superseded the National Research Development Committee (NRDC) on 28 June 1941. See Figure 3 for a diagram of the evolutionary development of civilian scientific support of the United States Army research and development program. The change from NRDC to OSRD was made by the President in Executive Order No. 8807 at the suggestion of Dr. Bush. It provided an agency to insure continuity of the armed services research and development programs from initiation through procurement. At the time this change was recommended the procedures being used by the armed services were neither integrated nor efficient. In addition, NRDC efforts were not being effectively correlated with the research and development activities of the military services.²⁸

The OSRD initially consisted of the Advisory Council, National Defense Research Committee, the Committee on Medical Research, Administrative Office and Liaison Office (for liaison with allied government research activities). Later two more principal sub-divisions were organized--the Scientific Personnel Office and the Office of Field Services. Both of these activities assumed increasingly important roles in U. S. operations research as the Scientific Personnel Office procured and processed the scientific personnel and the Office of Field Services

²⁷Ibid., pp. 267-271.

²⁸Stewart, pp. 35-37.

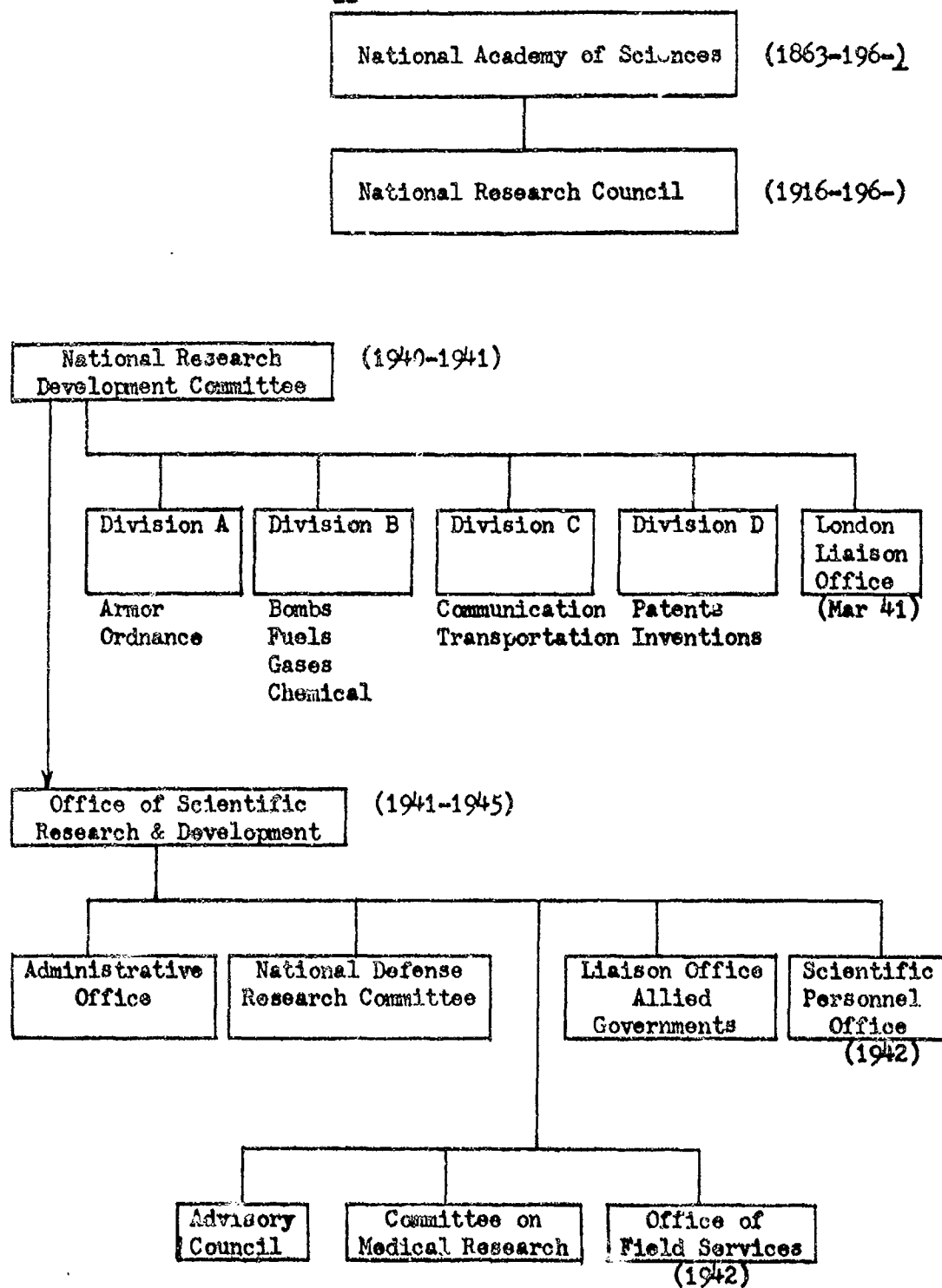


FIGURE 3

Evolution of Civilian Support of U. S. Military Research and Development.

(OFS) was the operational agency using their talents.²⁹

On 29 July 1941, the Office of the Chief of Research and Engineering of the Ordnance Department absorbed the Technical Staff of the Ordnance Department. The position of the Assistant Chief of Industrial Service for Research and Engineering was also integrated into the Office of the Chief of Research and Engineering. This office then became responsible for all research, development and engineering activities in the Ordnance Department. This change elevated research and development to division level within the Ordnance Department; but it was not important enough to rate a separate division.³⁰

From these early beginnings, the Army and the nation underwent a period of awakening and soul-searching in trying to solve their problems of military research and development. Prior to the threat of World War II and the release of research and development funds, research and development activities of the United States Army were very limited in scope and quality. Historically reliant upon American civilian scientists and industry for most of its basic research and production of materiel, the Army found itself with inferior equipment and few new ideas at the beginning of the war. Faced with many of the same problems, the British very successfully integrated the knowledge and abilities of their civilian scientists in a program to augment the military efforts. The success of this British program was used by U. S. scientists to gain support for their efforts to develop an autonomous civilian scientific organization to augment U. S. military research and development. Although

²⁹Ibid.

³⁰Barnes, pp. 3-6.

there was no direct entry into the field of operations research by the U. S. prior to World War II, American military and civilian researchers were using many of the techniques that would later be identified as operations research. With the advent of the National Research and Development Committee (NRDC) and its enlarged successor, the Office of Scientific Research and Development (OSRD), the foundations were laid for a systematic, integrated and productive use of civilian scientific talent to support the national research and development programs. This freed the technical services of the Army and Navy from the more time-consuming basic and long range research, and allowed the military services to concentrate on applied research.

CHAPTER III

CHILD OF WAR

Never in the field of human conflict
was so much owed by so many to so few.

Winston Leonard Spencer Churchill¹
(1874-1965)

British success in applying operations research to its military problems in the early stages of World War II was not lost on the American scientific community. The creation of the Office of Scientific Research and Development (OSRD) provided the vehicle and the impetus to thrust the United States firmly into the field of operations research. Shortly after the U. S. entered World War II the U. S. military began to establish and deploy supporting operations research groups. During the early months of the war each service developed operations research groups specifically tailored to support the separate service programs. Not until later was there any effort made to coordinate and integrate operations research activities throughout the U. S. research and development program.

The U. S. Navy was primarily interested in improving their knowledge in the fields of mine and submarine warfare and developed operations research groups to study these problems. Early in 1942, a small informal group headed by Dr. Ellis A. Johnson was formed at the Naval Ordnance Laboratory. This group was assigned the mission of studying mine warfare

¹The Oxford Dictionary of Quotations (2d ed., London: Oxford University Press, 1955), p. 144.

and mine warfare countermeasures. In May 1942, the Navy also established the Anti-Submarine Warfare Operations Research Group (ASWORG) through the National Research Defense Committee under contract with Columbia University. The mission of the ASWORG was to assist the Navy in developing anti-submarine warfare tactics, weapons, and material. Dr. Philip Morse was the first director of ASWORG and most of his assistants were physical scientists and mathematicians.²

The Army Air Corps was the first Army element to actively employ operations research. In early 1942, the Air Corps organized several operations research groups similar to the ones deployed with the Royal Air Force of Britain.³ The first Air Corps operations research groups were assigned to the strategic and tactical air forces in Europe and the Mediterranean.⁴ The most effective of these operations research groups was the one assigned to the 9th Air Force in Europe. This group was headed by Dr. Lauriston Taylor, formerly with the U. S. Bureau of Standards. Dr. Taylor and most of his assigned scientists were physicists.⁵ The results of the analyses by Dr. Taylor's group proved to be so valuable that the U. S. air forces in other theaters submitted requests for similar support. Eventually more than a hundred civilian scientists were occupied in this program. Throughout the war the primary effort of these groups was devoted to the analysis of bombing tactics and related

²Lynn H. Rumbaugh, A Look at US Army Operations Research--Past and Present (Washington, D.C.: Research Analysis Corp., RAC-TP-102, April 1964), pp. 1-3; Lincoln R. Thiesmeyer and John E. Burchard, Combat Scientists (Boston: Little, Brown and Co., 1947), pp. 25-26.

³Rumbaugh, pp. 1-3.

⁴Thiesmeyer, pp. 25-26.

⁵Rumbaugh, pp. 2-3.

weapon systems in order to improve the results achieved and simultaneously reduce the losses in men and equipment.⁶

The Army Air Corps also created the Operations Analysis Division as a major element of Air Corps Headquarters. This division was placed under the direction of Colonel W. Barton Leach. Colonel Leach in peacetime was a faculty member of the Harvard Law School. Throughout World War II the Operations Analysis Division was one of the most significant repositories of useful information on operations research in the Army. This was the agency that provided the continuity and detailed analysis to back up the efforts of the field operations research groups.⁷

In early 1942, Secretary of War Henry L. Stimson made an inspection of the Panama Canal Zone. During his inspection many deficiencies in the defensive system and plans were discovered. Upon his return Secretary Stimson conferred with Dr. Vannevar Bush, Director of the Office of Scientific Research and Development (OSRD), to determine the most effective means of obtaining prompt detached scientific analysis of the unusual and insistent defense problems of the Canal Zone. Dr. Bush recommended the establishment of an operations research group within the War Department. Such a group was commissioned and assigned the mission of developing plans and materiel to assist in the defense of the canal.⁸

Additional Army groups were formed by the Signal Corps and Ordnance Department. The Signal Corps organized an Operational Research Division headed by Professor William L. Everitt, a well-known communications engineer from Ohio State University. The primary mission of this

⁶Thiesmeyer, pp. 25-26.

⁷Ibid.

⁸Ibid., p. 25.

division was to analyze reports of communications performance developed at field communications stations in order to produce more effective instruction manuals.⁹ In addition the Operational Research Division studied various operational problems:

- 1) Characteristics of wave propagation were examined to discover a means of obtaining optimum results from ground and air communications equipment.
- 2) The problems of coordinating the operation of units into a single system were examined and recommendations made for elimination of the detrimental effects of interference caused by operation of multiple units within a restricted area.
- 3) The means of improving training methods and maintenance and servicing procedures were investigated.
- 4) Inquiry was made into the effect of such factors as vision, fatigue, and personal efficiency of operating personnel on ground and air communications equipment.¹⁰

The Ordnance Department sponsored a group called the Ballistics Research Annex, which was placed under the direction of Major Leslie E. Simon. The Annex was directed to conduct ballistics analysis in support of the Ballistics Research Laboratory using the University of Pennsylvania's differential analyzer.¹¹

In addition to all these formal groups established by the armed services and the Office of Scientific Research and Development (OSRD), there were many informal uses of operations research throughout the war. This type of activity is typified by an impromptu analysis made by Lynn H. Rumbaugh, subsequently a director of the Research Analysis Corporation.

⁹Rumbaugh, pp: 3-6.

¹⁰US War Department, Annual Report of the Army Service Forces for the Fiscal Year 1943 (Washington, D.C.: A Report to the Under Secretary of War and the Chief of Staff by the Director of the Service, Supply and Procurement Division, War Department General Staff, August 1943), pp. 6-7.

¹¹C. M. Green, Harry C. Thomson and Peter C. Roots, United States Army in World War II, The Technical Services, The Ordnance Department: Planning Munitions for War (Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1955), p. 226.

In June 1942, with no formal support or direction, Mr. Rumbaugh was requested to go to Australia to conduct an on-the-spot analysis of the raid on Sydney Harbor by four Japanese miniature (eighty-foot) submarines.¹²

These early operations research groups were quite small and usually supported a specific organization or activity. However, as operations research activities increased in magnitude and the requirements for military and industrial manpower expanded, conflict developed in properly managing available scientific talent. The operations research scientists of World War II were primarily physicists, engineers and mathematicians who were in short supply throughout the war. However, there were many notable exceptions. The British discovered early that natural scientists with their training in making measurements and observations among a clutter of uncontrolled variables were very useful in operations research analysis. The United States added the talents of other disciplines including lawyers, such as John Marshall Harlan--who was later an associate justice of the United States Supreme Court.¹³

Many operations research groups established during the early part of the war found much of their effort being absorbed in working on problems generated by the various field commands. Most of these problems were technical in nature and were quite foreign to those of statistical and analytical analysis typical of operations research. However, because of their scientific background and their professional associations,

¹²Rumbaugh, pp. 1-3.

¹³Ibid.

the operations research scientists could cut through a lot of red tape and get prompt answers and results. The rapid transmission of such requests to other technical scientists and agencies more adept at solving this type of problem reduced the time required to develop new or modify existing equipment. One result of this situation was the planned incorporation of weapons experts within operations research groups.¹⁴

Early in 1943, Dr. Bush thought the Office of Scientific Research and Development (OSRD) should establish a sub-division specifically devoted to the integration of all demands for operations research support. Dr. Bush also believed that operations research should be used by the military services, but he recognized that OSRD would have to bear the brunt of providing the additional scientific manpower to satisfy the service requirements. To resolve this problem, Dr. Bush commissioned Mr. Carroll L. Wilson, his executive assistant in OSRD, to organize a committee to study military requirements for operations research and other field scientific assistance. This study became the basis for the development of a new sub-division of OSRD.¹⁵

Upon completion of the study, Mr. Wilson recommended assigning the new sub-division the responsibility for supervision, direction, coordination and integration of all activities of a field-service nature. This included all services by OSRD or its contractors and incorporated not only operations analysis but also field engineering of installations, maintenance and modification of equipment; organization and operation of laboratories established in war theaters; field consultation and the

¹⁴Thiesmeyer, pp. 26-27.

¹⁵Ibid., pp. 28-29.

work of special committees or missions for the study of field problems; and exchange of scientific information obtained from military operations.¹⁶

On examining this study Dr. Bush determined that the recommendations, if adopted, would satisfy field requirements for operations research, technical advice, representatives, liaison, etc. Initially he considered naming this sub-division of OSRD the Operations Analysis Division. Later however, Dr. Bush decided that the Office of Field Services was a more descriptive and comprehensive label. The announcement of the organization of the Office of Field Services (OFS) was made by Dr. Bush on 15 October 1943. OFS was formally established by OSRD Administrative Order No. 4 on 8 November 1943. Its staff consisted of Dr. Karl T. Compton, President MIT, chief; Dr. Alan T. Waterman, associate professor of physics on leave from Yale, deputy chief; and Dr. Lincoln R. Thiesmeyer, geologist and member of the Anti-Submarine Warfare Operations Research Group, head technical aide.¹⁷

The OFS was assigned the following functions:

Under the general supervision and direction of the Director, the Office of Field Services shall direct, supervise and coordinate the rendering by the Office of Scientific Research and Development or its contractors to the Armed Services of the United States and its allies of certain field services designed to (i) make the most effective possible use of developments by the United States or its allies on mechanisms or devices of warfare or in military medicine, and (ii) minimize the effectiveness of any such developments made by the enemy, especially those in combat use. Principal among such services shall be operational research, field engineering, the organization and operation of laboratories established in military fields of operation, the work of ad hoc committees or missions for special study of field problems, the analysis of information contained in reports or derived from consultations concerning scientific problems arising in connection with military combat operations, and, subject

¹⁶Ibid.

¹⁷Ibid., p. 67.

to the policies fixed by the Scientific Personnel Office, the employment and training of personnel needed for such activities.¹⁸

The varied functions of OFS fell generally into the following major categories:

(1) procurement and processing of civilian specialists in science and technology for loan to war activities, predominantly for temporary duty overseas in theaters of military operations; (2) indoctrination of personnel procured for field service in developments of NDRC, in military procedures, or in the application of certain scientific techniques to problems of warfare; (3) establishment, staffing and supervision of "projects" on direct request from the armed forces, both at home and abroad; these covered a broad range both geographically and in the fields of special scientific knowledge; (4) informal assistance from both the central office of OFS and from its field men to the Army, the Navy, units of OSRD, or other war activities in matters of procuring scientific personnel, exchanging technical information or setting up and manning activities that had scientific or technical aspects; (5) informal assistance in the placement of officers, enlisted personnel, or draftees with technical background; (6) informal assistance to NDRC divisions in promoting field missions.¹⁹

The services rendered by OFS included:

. . . analysis and outlining of problems in which civilian aid could prove helpful; analysis of military and naval operations resulting in recommendations for revision of tactics; assistance with installation and maintenance of equipment or with training of military personnel in its proper use; analysis of the performance of new weapons and devices under field combat conditions, which might result in modifications back at the laboratories; assistance in promoting the flow of technical information between laboratories and production plants and the field users; assistance in the procurement of scientific intelligence; counsel on improving the utilization of personnel within the armed forces.²⁰

Dr. Bush made an administrative decision to exclude most of the operations research groups already organized and operating in the field from the direction and supervision of OFS. This decision resulted in

¹⁸Irvin Stewart, Organizing Scientific Research for War (Boston: Little, Brown and Co., 1948), p. 129.

¹⁹Ibid., p. 130.

²⁰Ibid., p. 131.

focusing OFS interest primarily in the Pacific area as the European area was well supported by existing operations research groups. In the Pacific the Army Air Corps had deployed operations research sections with the numbered air force headquarters. This left the Navy and the Army ground forces as the most profitable potential users of OFS services. Although the Navy was the first service to take notice of the creation of the Office of Field Services and to make use of it, the Army became its largest customer. Out of a total of eighty-seven separate projects undertaken by OFS, fifty-five were Army sponsored and ten were joint requirements of both the Army and Navy. The remaining twenty-two projects were sponsored by the Navy or another government agency.²¹

Initially the War Department designated its Operations Division to be primarily the Army's liaison with OFS. It soon became apparent that the number of personnel actions required to support OFS field operations exceeded the ability of the Operations Division to process them. This division was already under very heavy pressure trying to keep up with all the operational matters from the ever-expanding theaters of operations. Consequently, the responsibility for liaison with OFS was shifted to the New Developments Division of the War Department. This division remained the Army's major administrative channel for field services during the remainder of the war.²²

To initiate the Office of Field Services activities in the Pacific area, Dr. Compton made a liaison visit in January 1944 to solicit requirements and establish contacts with the military commanders

²¹Thiesmeyer, p. 39.

²²Ibid., pp. 40-41.

and any scientific groups already deployed there. Dr. Compton was warmly received on his first stop in Hawaii. He conferred with Admiral Chester A. Nimitz, Commander in Chief, Central Pacific Area; Lieutenant General Robert C. Richardson, Commanding General, Army Forces Central Pacific Area; Brigadier General William O. Ryan, Commanding General, Pacific Wing; and others. From this successful beginning, Dr. Compton continued on to Australia. In Australia General MacArthur enthusiastically received Dr. Compton's recommendations for the establishment of supporting field projects in the Southwest Pacific Area. These field projects would be staffed and supported through OFS and OSRD. To insure the proper command support for these projects, General MacArthur directed Major General Spencer B. Akin, his signal officer, to act for him in future discussions and matters of organization.

Following his successful meeting with MacArthur, Dr. Compton returned to the U. S. by way of the South Pacific Area Headquarters at Noumea where he lunched with Admiral John Franklin Shafroth, Jr., the area deputy commander in chief. He also conferred with Lieutenant General Millard F. Harmon, Jr., and his brother, Major General Hubert R. Harmon, who commanded the Thirteenth Air Force. Each of these officers expressed an intense interest in obtaining increased scientific and engineering help. The operational research section, which Colonel Leach had assigned to the Thirteenth Air Force, had been so effective that Dr. Compton did not have any difficulty selling the local ground force commanders on the desirability of expanding this type of activity to their operations. General Millard Harmon specifically requested a tailored group to study and advise on jungle warfare problems. Dr. Compton was very impressed by this warm reception in Noumea and felt that the South

Pacific Area commanders had progressed further in analyzing their needs than the other Pacific headquarters.²³

Armed with these requirements from the field, Dr. Compton rushed back to Washington to get OFS moving. The Office of Field Services began in a very limited fashion; but by the end of the war it had dispatched over 300 scientists and technical men overseas--two-thirds to the Pacific area. OFS also assigned approximately 200 men to projects in the U. S. Throughout the war much of the OFS office staff effort was devoted to giving advice and answering questions originating from the OFS and other field operations research groups.²⁴

Two major branch offices of the OFS were eventually established in the Pacific area--one at Oahu, Hawaii and the other at Brisbane, Australia. The latter was eventually moved from Brisbane to Hollandia, New Guinea, then on to Leyte and finally to Manila in the Philippines. Dr. George R. Harrison was selected to head the Australian Branch, which was designated the Research Section of the Signal Office in MacArthur's headquarters. Although this office was under the general staff supervision of General Akin, it functioned as an unwanted step-child through a year of frustrating island-hopping, fragmented effort, and communications and travel problems that limited full utilization. Finally, in the Summer of 1945, permission was granted to establish a more permanent office in Manila. This office was to be complete with high level operating channels and the support that had previously been denied due to the rapidly changing situation.

²³Ibid., pp. 30-31, 41-42.

²⁴Ibid., pp. 48-50.

The Office established in Oahu, Hawaii, under the leadership of Dr. Lauriston C. Marshall, a physicist from the faculty of the University of California and a former director of the British Branch Radiation Laboratory, was more fortunate. After its arrival in May of 1944, it was given permanent working areas and support and it became the nerve center for most of the operations research effort conducted in the Pacific area. The office was eventually expanded to nearly fifty scientific personnel. Care was taken to insure cooperation and prevent duplication of existing operations research sections which were already assigned to numbered air force headquarters throughout the theater.²⁵

Two types of problems were most commonly directed to World War II operations research groups for study and advice. These problems took the form of work simplification and operational problems. The work simplification problems covered the broad spectrum from processing intelligence documents and eliminating unnecessary travel to examining and recommending heavy construction techniques.²⁶

Some of the operational problems undertaken by operations research groups during World War II were of the following type:

What patterns of flight for an air patrol will give the best protective coverage against submarines to convoys of various sizes, shapes and speeds?

Would a hundred 50 pound bombs create greater or less damage to a certain type of target than five 1,000 pound bombs?

With a particular combination of weapons and tactics, what effects does modification of either the equipment or the procedures have on the probability of success in either offense or defense?²⁷

²⁵Ibid., pp. 48-52.

²⁶Ibid., pp. 202-212.

²⁷Ibid., pp. 23-24.

Operations research during World War II had a direct role in initiating requirements for and developing many new ideas into usable devices. Operations research scientists were also asked to recommend the most effective employment of these new devices and other in-service items. Some typical examples of new developments in which operations research played a part are: radar, counter-radar devices and tactics, anti-submarine warfare tactics, bombing tactics and loads, the VT fuse, rockets and bazookas, ground approach radar, Loran navigation system, frangible ammunition, hypervelocity guns and improved machine gun barrels, electronic antiaircraft director and many other items including a whole new generation of land and sea-going vehicles.²⁸

Following the surrender of Germany more and more of the available operations research support was transferred to the Pacific area. Recognizing that the continued existence of the OFS and its parent organization, OSRD, was only temporary, Dr. Bush began casting about for a means of continuing this type of effort during peacetime.²⁹ Earlier, in June 1944, the need for continuing long-term fundamental research was recognized by the Secretary of the Navy and the Secretary of War. They recommended the formation of an interim Research Board for National Security. This board was to be made up of distinguished civilian

²⁸Stewart, pp. 161-164; James Phinney Baxter, 3d, Scientists Against Time (Boston: Little, Brown and Co., 1948), pp. 100-117; Don K. Price, Government and Science (New York: New York University Press, 1954), p. 175.

²⁹US War Department, Annual Report of the Army Service Forces for the Fiscal Year 1945 (Washington, D.C.: A Report to the Under Secretary of War and the Chief of Staff by the Director of the Service, Supply and Procurement Division, War Department General Staff, 10 November 1947), pp. 159-160.

scientists under the auspices of the National Academy of Sciences. As a result of this recommendation, the Joint Research and Development Board was organized in early 1945 with fifteen or sixteen subordinate committees in various specialty fields. Legislation for establishment of a permanent postwar board was introduced in Congress in 1945 and approved in 1946.

The committees of the Joint Research and Development Board included representatives of the military services and several eminent civilian scientists--one who served as the committee chairman. The purpose of these committees was to review the various research programs of the military, to advise on ways to accomplish the programs, and to update the services in the latest scientific thought. Each committee had subordinate panels and subpanels; and altogether this represented a fine deliberative and decision-making forum.³⁰

The creation of the Joint Research and Development Board committees was accompanied with several advantages and disadvantages. One of the most significant advantages was that it forced the military to review its programs before relatively impartial outside experts. In addition, the existence of the committees kept many of the most competent scientists in close association with the military services during peacetime. But this system also had some marked disadvantages. The ten to fifteen days per year part-time service rendered by the civilian scientists restricted the depth of their knowledge of the military situation. This lack of knowledge limited the validity of their recommendations. Another disadvantage was the difficulty in obtaining the services of qualified scientists. Some fields had sufficient experts available in civil

³⁰Price, pp. 144-145.

life (atomic energy and aeronautics) but these experts were often difficult to recruit for specific advice applicable to military requirements especially in developing new techniques of warfare, new weapons and solving new operational problems.³¹

In September 1947, under the provisions of the National Security Act of 1947, which established the Department of Defense and reorganized the War Department and the Navy Department, the Research and Development Board was established within the Department of Defense. This board provided centralized direction to defense research and development activities and conducted special research projects for the Department of Defense. The Research and Development Board was made up of both military and civilian scientists who shared research and development authority and responsibility.³²

In the Fall of 1947, following the reorganization of the Defense Department, the Weapons Systems Evaluation Group (WSEG) was developed as an adjunct of the Joint Chiefs of Staff. This agency provided a forum to encourage inter-service communication, integration and correlation of research and development efforts in weapons systems.³³

The Army had not been idle during this period following the war. Impressed by the success of the operations research groups which had served in the field and laboratory, the Army took control of and continued many of these groups when the war ended. As it would have been difficult to maintain the field service offices, the operations research

³¹Ibid., pp. 144-146.

³²Green, et al., p. 231.

³³Rumbaugh, p. 5.

activities in the Army following World War II were generally restricted to laboratory studies. Most post-war operations research effort was devoted to analyzing the mass of data collected during the war.³⁴

In summary, operations research in World War II grew from infancy to mature childhood. When the late Sir Winston Churchill spoke so stirringly "seldom have so many owed so much to so few," he might well have been speaking of the operations research scientists instead of or in addition to the fighter pilots of the RAF.³⁵ Most applications of operations research during World War II were in the field of weapons and equipment use, but operations research also contributed significantly to the development of new equipment to satisfy requirements from the field. To assist in this task a special organization, the Office of Field Services, was established within the Office of Scientific Research and Development. The Office of Field Services provided a more responsive source of technical and scientific aid and augmented previously established operations research groups serving with the various theater air forces and other army elements. By the end of the war operations research groups were deployed in every theater and had proved their value many times over. The application and importance of operations research during World War II is very well summarized by the comments of Admiral Ernest J. King, U. S. Navy, in a final report submitted to the Secretary of the Navy during September 1945:

The complexity of modern warfare in both methods and means demands exacting analysis of the measures and countermeasures introduced at every stage by ourselves and the enemy. Scientific research can

³⁴US War Department, Annual Report ASF, FY 45, pp. 156-160.

³⁵Price, p. 126; E. S. Quade, Military Analysis (Santa Monica, Calif.: Rand Corp., Memo RM 4808 PR, November 1965), pp. 1-3.

not only speed the invention and production of weapons but also assist in insuring their correct use. The application, by qualified scientists, of the scientific method to the improvement of naval operating techniques and material, has come to be called "operations research." Scientists engaged in operations research are experts who advise that part of the Navy which is using the weapons and craft--the fleets themselves. To function effectively they must work under the direction of, and have close personal contact with, the officers who plan and carry out operations of war. . . . operations research as it developed, fell into two main categories; theoretical analysis of tactics, strategy and the equipment of war on one hand; statistical analysis of operations on the other.³⁶

As the war ended, the Office of Field Services and the Office of Scientific Research and Development, were eliminated but steps were taken to establish joint boards combining both military and civilian scientists to continue the wartime relationships and insure continuity in the research and development programs.

³⁶P. M. Morse and G. E. Kimball, Methods of Operations Research (1st ed. rev.: New York: The Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc., 1952), p. 3.

CHAPTER IV

EVOLUTION TO MATURITY

War is much too serious a thing to be left to military men.

Charles-Maurice De Talleyrand¹
(1754-1838)

Due to the newness of the method, operations research activities conducted during World War II were primarily limited to analyses of action problems involving aircraft, ships, submarines and simple weapons systems. This type of problem was essentially two dimensional with the general characteristics of a duel. Complex interaction problems were not undertaken. Most data to support these World War II operations projects was obtained from the field forces of the Army.²

With the phasing out of the Office of Scientific Research and Development (OSRD) at the end of World War II, the armed forces were forced to fill the vacuum created by the resultant loss of scientific support. This loss was especially felt in the field of basic research because OSRD had sponsored most of the basic research accomplished by the U. S. during the war. The Joint Research and Development Board and various military research groups such as the Navy's Operations Evaluations Group (OEG), the Air Force's operations analysis groups, and the

¹The Oxford Dictionary of Quotations (2d ed., London: Oxford University Press, 1955), p. 520.

²Lynn H. Runabaugh, A Look at US Army Operations Research--Past and Present (McLean, Va.: Research Analysis Corp., Tech. Paper RAC-TP-102, April 1964), p. 5.

Army's technical services were the principal agencies continuing operations research immediately following the war.³

The next step in the development of operations research by the Army was the adoption of the contractual agency concept. The Air Force initiated this type of association in March 1946 with the development of Project RAND through the Douglas Aircraft Company. In 1948, Project RAND became the Rand Corporation. The Rand Corporation has remained a primary operations research agency for the Air Force.⁴

The Army's first venture with a contract agency, the General Research Office (GRO), was formally initiated in July 1948, with a one million dollar contract negotiated with the Johns Hopkins University. Headquarters for this organization was established in buildings of the Industrial War College at Fort Lesley J. McNair in Washington, D. C. The Department of the Army initiating directive, DA Memo 3-50-2, dated 20 September 1948, creating GRO specified that:

- 1) The GRO was under the direct supervision of the Deputy Director for Research and Development, Logistics Division, Department of the Army.
- 2) The GRO was responsible for the following functions:
 - a) Operations research and/or analysis of Army-wide problems not unique to any one Army agency.
 - b) Basic research of a non-materiel nature which was not the responsibility of a specific Army agency.
- 3) An advisory committee was established under the chairmanship of a

³General Research Office, General Research Office Quarterly Report, Vol. 1, No. 1 (Washington, D.C.: General Research Office, The Johns Hopkins University, 30 September 1948), p. 9.

⁴Rumbaugh, pp. 5-6.

GRO project officer to assist in the selection of projects and the assignment of priorities. This committee consisted of members of each technical service, each general staff division, and representatives of the Army Field Forces and the Army Comptroller.⁵

The GRO was initially organized with a staff consisting of a director, Dr. Ellis A. Johnson, a physicist, who served with distinction as an operations research scientist in the Pacific area during World War II; five other research scientists, three of whom had extensive wartime operations research experience; and twelve administrative personnel. The director and all technical personnel participated directly in the research program. It was planned that the technical staff of GRO would eventually consist of approximately fifty percent physical scientists, forty percent human scientists and the remainder from professions related to human relations.⁶

The problems undertaken by the General Research Office were restricted to those which satisfied the following policy criteria established by the Department of the Army:

- 1) Problems that will eventually involve major action by the Army.
- 2) Problems involving integration of military and technical courses of action especially if two or more agencies of the Army are involved. Specific problems of technical planning and materiel development will not be undertaken as they are the responsibility of the technical branches.

⁵Ibid.; GRO, GRO Report, Vol. 1, No. 1, pp. 9-11, 22-25; GRO Today (Chevy Chase, Md.: Operations Research Office, The Johns Hopkins University, January 1955), p. 1.

⁶GRO, GRO Report, Vol. 1, No. 1, pp. 22-25.

3) Problems involving the Army but not those of a joint nature except for specific Army portions of such problems.⁷

At the time that the General Research Office was organized, there were many problems being considered by the Army that were adaptable to solution using operations research techniques. A sampling of these projects reflect the continued influence of the problems and data collected during World War II on post-war research and development projects:

- 1) Analysis of individual protection from all forms of warfare.
- 2) Studies comparing short range guided missiles, free rockets and artillery.
- 3) Optimum fire control systems for field artillery and elimination of errors.
- 4) Analysis of supply reporting techniques.
- 5) Feasibility of logistics support of an airhead as opposed to a beachhead.
- 6) Analysis of air-to-ground and ground-to-air recognition systems.
- 7) Developing a fully integrated communications system for a field army to include analysis of data transmitted and modes of transmission.
- 8) Improvement of techniques for collection of foreign intelligence, processing this intelligence and disseminating it to interested agencies.
- 9) Effects of enemy propaganda and techniques for neutralizing this propaganda. A corollary to this problem was the study of factors and techniques to destroy enemy will to fight and how to best prepare our own troops to succeed in battle.
- 10) Analysis of ways and means to encourage the application of atomic

⁷Ibid., pp. 20-21.

energy and radioactive materials to military problems to include the development of weapons and equipment.⁸

Projects proposed by the Department of the Army and accepted by the GRO prior to January 1949, included:

- 1) Analysis of individual protection means from all known forms of warfare.
- 2) Analysis of predicted artillery fires.
- 3) Analysis of antiaircraft weapons and systems (scientific analysis of the entire antiaircraft problem--exclusive of piloted aircraft).
- 4) Analysis of performance of Army equipment under all environmental conditions.
- 5) Project MAID--Analysis of the U. S. program of military aid to foreign countries.⁹

It was in 1948 that the Army first formally recognized the necessity for analysis of problems to achieve the best cost/result ratio. Major General A. C. McAuliffe, Deputy Director for Research and Development, Logistics Division, General Staff, discussed this situation in the foreword to the General Research Office's first quarterly report dated 30 September 1948.¹⁰ In later years this cost/effectiveness, as the term was called, became increasingly important as technology advanced and costs for research, development and procurement skyrocketed.

⁸Ibid., pp. 21-22.

⁹Ibid., pp. 14-20; Operations Research Office, Operations Research Office Quarterly Report, Vol. 1, No. 2 (Washington, D.C.: Operations Research Office, The Johns Hopkins University, 31 December 1948), pp. 7-29.

¹⁰GRO, GRO Report, Vol. 1, No. 1, pp. 4-5; GRO Today, Foreword and p. 1.

On 27 December 1948, the name General Research Office (GRO) was officially changed to the Operations Research Office (ORO). This change was made after it became evident that the title General Research Office was misleading, as the sole function of this agency was to conduct operations research studies.¹¹

By the time that ORO's quarterly report was published in December 1948, ORO scientists had reached two important conclusions:

1) Preliminary analysis of assigned projects indicated that certain basic problems were common to all projects.

2) Solutions to these problems required cooperative action on the parts of the Army, Navy and Air Force.

In addition to these conclusions it was observed that the increased importance of human factors in the proposed analyses required the addition of social scientists to the technical staff of ORO.¹²

Department of the Army Special Regulations 705-5-5, dated 13 January 1949, directed the Operations Research Office:

. . . to apply scientific, qualitative and quantitative analysis to the study of warfare with the objective of improving the strategy, tactics, logistics, weapons, and weapons systems of the future.¹³

This was the first formal attempt by the U. S. Army to refine and promulgate a specific mission in terms directly related to the field of operations research.

In April and May 1949, the first tri-partite conference on

¹¹Ibid., Foreword and pp. 1-6.

¹²Rumbaugh, p. 6; ORO, ORO Report, Vol. 1, No. 2, pp. 3, 5, 6.

¹³Operations Research Office, Operations Research Office Report, Vol. II, No. 1&2 (Washington, D.C.: Operations Research Office, The Johns Hopkins University, 30 June 1949), Foreword.

operations research was held in London by operations research groups of Britain, Canada and the United States. The exchange of information and ideas from the conference resulted in significant benefits for the participating nations. In addition, agreements on standardization and data exchange were formulated.^{14/15} This conference in London was an eye-opener to the participating U. S. scientists because it was attended by most of the senior staff officers of the British General Staff.

Upon their return to the United States, the participating ORO scientists developed several staff studies analyzing the various projects assigned ORO compared with the actual research requirements of the General Staff of the Army. These staff studies resulted in three important conclusions:

1) The necessity for continuing close coordination and cooperation of the separate operations research programs of the U. S., Great Britain and Canada. One means of accomplishing this coordination was to exchange scientists. This exchange of liaison personnel was accomplished between Britain and the United States soon after the conference.

2) Operations research in the U. S. Army should not be centralized in a single agency such as ORO. Operations research groups should be established at the primary decision-making levels: weapons laboratories for the analysis of weapons; at the headquarters and boards of the Army for development of new tactics; and at the general staff level for strategic decisions.

3) Operations Research Office scientists must work in close coopera-

¹⁴Ibid., p. 1.

¹⁵Later, in June 1963, Australia was nominated and accepted for membership in this conference.

¹⁶ORO, ORO Report, Vol. II, No. 1&2, pp. 1-2.

tion with their military colleagues. This insured maximum availability of practical military know-how to the analyst during his conduct of the operations research analysis.¹⁶

By June 1949, the ORO had developed from its initial staff of five scientists to over twenty-five technical personnel most of whom had World War II combat experience. The largest internal problem of ORO during this period was training these new personnel in operations research techniques. Although all of these new personnel had good scientific backgrounds, most had no previous experience in the use of operations research. Training in both strategic analysis and specific weapon technological problem-solving were essential to the ORO analyst to prepare him to undertake projects assigned to ORO. With this thorough training the ORO scientist was well equipped to keep up with the rapidly changing requirements that were placed on ORO in the following years.¹⁷

In 1950, during the prelude to the Korean War, the National Academy of Sciences was called back into active operation. Its function was to evaluate the scientific research programs being undertaken by agencies of the federal government. Another mission assigned the Academy was to undertake and support basic research activities required by the military services.¹⁸

The concept of systematically analyzing the Army of the future was first undertaken in 1950, when the Secretary of the Army commissioned the California Institute of Technology to begin Project VISTA. The

¹⁶ORO, ORO Report, Vol. II, No. 142, pp. 1-2.

¹⁷Ibid., pp. 3-4.

¹⁸Ibid., p. 1.

purpose of this project was to answer the questions:

- How to prepare for the battlefield of tomorrow?
- How to best organize combat forces to meet these requirements?
- What tactics and techniques should be employed?
- What equipment is required?
- What logistic system will best support such a battlefield?¹⁹

The report rendered by Project VISTA's commission in February 1952, highlighted three factors:

- 1) A ten year forecast of future requirements in tactics, weapons and equipment was essential for effectiveness and survivability.
- 2) A requirement existed for a centralized system to coordinate and integrate future developments in organization and tactics.
- 3) There was a need for a development group within this centralized system composed of combat personnel augmented by civilian scientists to field test new developments in organization and tactics.

As a result of the Project VISTA recommendations, the Chief of Staff of the Army directed the establishment of a Combat Developments Group at Headquarters, Army Field Forces (later redesignated United States Continental Army Command--USCONARC). The Combat Developments Group eventually consisted of some thirty service schools, materiel developments agencies and test and training centers, with missions ranging from doctrinal developments to hardware testing. However, the report's recommendation for the development of a field laboratory was not adopted in these early years.²⁰

¹⁹Don K. Price, Government and Science (New York: New York University Press, 1954), p. 60.

²⁰Harauld D. Laugham, LTC, Historical Summary, United States Army Combat Developments Command Experimentation Center, 1 Nov 1956--30 June 1964 (Ft. Ord, Calif.: US Army Combat Developments Command Experimentation Center), p. 2.

The Korean War was a true operations research laboratory. The Operations Research Office (ORO) dispatched many field research teams to provide direct, immediate assistance in solving the Army's problems in the field.²¹ These ORO scientists worked and lived with the soldiers in the field. After the truce was signed 113 members of these field ORO teams received the Korean Service Medal for their work in the combat zone.²² These scientists concentrated their efforts on hardware research as the operations research scientists of the Office of Field Services did during the second world war. However, much of their effort was devoted to collecting data to support long range studies and other projects which were not adaptable to field study. Some of the projects in this category that were later analyzed are:

- 1) How to measure the effectiveness of psychological warfare.
- 2) Analysis of the effectiveness of artillery.
- 3) Analysis of the results of close air support.
- 4) The use of native troops and labor.
- 5) The Army's relationship with the local government.
- 6) The use of negro troops. (This study found that integration worked quite well and recommended that it be extended to the rest of the Army).
- 7) Examination of the combat behavior of the individual soldier.²³

The importance of the individual, his attitudes and physical condition, were well-known problems to the military commanders of World War

²¹ORO Today, pp. 1-4.

²²Rumbaugh, p. 15.

²³ORO Today, pp. 1-4.

II and Korea. These problems came under increasingly detailed scrutiny of the operations research scientists of these wars.²⁴ In order to provide greater continuity to the investigation of these problems, the Joint Military-Civilian Committee on Human Resources was established on 26 March 1948, by direction of the Joint Research and Development Board. From this committee evolved several in-house and contractual groups applying operations research to the study of human resources. The Committee on Human Resources consisted of four civilian members, one of whom was the chairman, and two military representatives each from the Army, Navy and Air Force. The missions assigned the committee were:

- 1) Continuously monitor and survey human resources research and development within and outside the military services.
- 2) Collect human resources information from all domestic and foreign sources, analyze the information, insure prompt dissemination, and supervise the resultant research and development programs.
- 3) Prepare and present reports on trends in human resources activities.
- 4) Develop and implement plans to insure the best use of available human resources.²⁵

The importance of the individual in influencing the effectiveness of a system or operation was the basis of a study on human factors in military operations conducted jointly in 1950-1951 by the Operations Research Office and The Working Group on Human Behavior Under Conditions

²⁴Ibid pp. 4-5; Rumbaugh, pp. 7-8.

²⁵US Research and Developments Board, Committee on Human Resources (Washington, D.C.: Directive from the Research and Developments Board, 28 March 1948).

of Military Service. This study was the source of a large number of additional research requirements which prompted the Army to negotiate a contract in August 1951 with the George Washington University establishing the Human Resources Research Office (HUMRRO) in Alexandria, Virginia.²⁶

The Human Resources Research Office (HUMRRO) was assigned the mission of conducting research in training methods, motivation, morale leadership and psychological warfare. Most of the specific problems undertaken by HUMRRO were old ones--old in that they had been with the Army for a long time. These problems revolved around the individual soldier, his training and his environment. Thus HUMRRO provided the Army with a means to add emphasis to its investigation of these old problems and simultaneously to insure a ". . . disinterested scientific approach to gathering facts, controlled experimental approach with careful measuring devices and the orderly examination of data from a research point of view."²⁷

From its original austere centralized organization consisting of a central office with three operating divisions, HUMRRO expanded to a functional decentralized organization that had only one home division and accomplished most of its work through five Army Field Forces Human Research Units (AFFHRU) or (HRU).²⁸ See Figure 4 for a diagram of the

²⁶Richard Hays Williams (ed.), Human Factors in Military Operations (Washington, D.C.: Operations Research Office, The Johns Hopkins University, 7 January 1954), p. 4.

²⁷Human Resources Research Office, What HUMRRO is Doing (Washington, D.C.: Human Resources Research Office, HUMRRO Research Bulletin No. 1, George Washington University, March 1954), pp. iii, iv.

²⁸Human Resources Research Office, What HUMRRO is Doing Jul 57--Jun 58 (Washington, D.C.: Human Resources Research Office, HUMRRO Bulletin No. 5, George Washington University, December 1958), p. iii.

organizational evolution of HUMPRO.

Although great strides had been made by the Army prior to and during the Korean War to insure that the Army research and development programs were effective, significant controversy relative to this effectiveness developed with the U. S. scientific community. In a speech at the University of Minnesota in September 1952, and again in May 1953, in Washington, D. C., Dr. Lloyd V. Berkner, a noted engineer and physicist with a long history of government scientific affiliations including operations research, argued strongly for the revival of an organization similar to the Office of Scientific Research and Development (OSRD). He argued that this type of organization was needed to give the scientist the opportunity, without military restrictions to exploit new technological developments for military purposes. Dr. Berkner expressed the view that many scientists felt there was a significant gap in basic research. In his view this gap had been created by the absence of a civilian directed research agency authorized to freely investigate new ideas for the military whether they wanted them or not. Dr. Berkner also felt that the civilians under contract to the military services were being overly restricted by their military superiors and as a result there was no latitude for scientific disagreement and no freedom to conduct wider research in promising but perhaps unrelated areas.²⁹

On the other hand, many civilian scientists felt that the contractual system that had evolved since World War II merged the private and public interest in research and development very thoroughly and effectively. It provided a means for the military services to gain the

²⁹Price, pp. 140-142, 175-176.



HUMRO Organization Evolution (1951-1959)

finest engineering and scientific talent and services in order to pursue specific research problems. The scientists involved in these activities indicated that this system had not limited their academic freedom because the proposed projects of the armed services had to be approved by the contractor before work began. Another contractual device available to the scientist was the ability during the research and development cycle to go back to the originator in order to re-define or effect other changes in the project if this is required to accomplish the purpose of the contract. In addition to provisions for making changes during investigation, most contracts also included authority to conduct a specific amount of self-generated research. Considering the in-house research and development agencies of the Army and the advantages gained from using contractual agencies, the Army's research and development posture was pretty good. Undoubtedly it could have been better, but the type of research and development envisioned by Dr. Berkner called for almost unlimited funds. Basically the same results were achieved in a much more limited fashion from the Army's in-house capabilities and the associated contractual agencies through the application of operations research to analyze the problem and to identify and recommend courses of action. This process allows the decision-maker to concentrate the limited research and development funds in areas of greatest need.

However, this emphasis on the development of service related contract research agencies created a problem. By 1952, so many studies had been initiated and competition for qualified scientists was so demanding that the Joint Research and Development Board insisted on the military services obtaining the Board's approval prior to negotiating any more contracts.³⁰ An example of the type of study group that the Research and

³⁰Ibid., pp. 91-92, 142, 174.

Development Board was concerned about was the Study Group on Continental Defense which was created in 1952 by the Secretary of Defense and was chaired by Dr. M. J. Kelly of the Bell Telephone Laboratories. Although this group was short lived, the area of investigation assigned to it actually cut across all the services and thus in some measure duplicated work that other agencies had already accomplished.³¹

Following the Korean War most ORO research effort was devoted to analyzing the mass of data collected during the war. In 1953, to more effectively analyze problems of the post-war field army forces, the Operations Research Office created another agency, the Combat Operations Research Group (CORG) at Headquarters, United States Continental Army Command (USCONARC), Fort Monroe, Virginia. This change was the first step in a major reorganization of ORO which occurred the following year. In 1955, CORG was passed from ORO to the Technical Operations, Inc., of Washington, D. C. This was a new contractual agency specifically developed to support USCONARC in investigation of problems relating to the nuclear battlefield.³²

On 1 April 1954, the Operations Research Office (ORO) continued its reorganization to meet the gradual but important changes in the types of projects it was assigned and to keep up with an increased volume of work. One of the most important considerations in this reorganization was the recognition that ORO problems had outgrown the project method of investigation. The assigned research problems had evolved from relatively simple weapons analyses to the more sophisticated problems of design-

³¹Ibid., pp. 92, 155.

³²Rumbaugh, p. 6.

ing weapons, systems, tactics and strategies for the future. This transition from analyzing hardware to the development of intangibles like strategy and tactics meant that problems were no longer easily classified. Under the project system these problems became too large for the assigned project group to handle.

Key points in the reorganization are as follows (See Figure 5):

1) Scientific investigation was reorganized from a project to mission basis. This change provided greater flexibility for tactical and strategic research because very few problems now being analyzed fit the project classification.

2) Each division was assigned a broad mission to facilitate the accomplishment of special studies within the framework of the division instead of having to extend the study outside the division.

3) Each division was delegated a great deal of authority and made almost autonomous. In addition, the division was assigned the primary responsibility for designing and carrying out its own work programs.

4) With the addition of an associate and assistant director, the new organization provided for better coordination with Army agencies as it allowed the director more time to plan the overall operations research program.

5) Greater emphasis was placed on tactical and strategic studies.³³

The Operations Research Office (ORO) started with just two assigned projects in 1948; but by the time it reorganized in 1954 ORO was engaged in solving seventeen projects having completed four others. Some of the problems under analysis during this period were:

³³ORO Today, Foreword, pp. 4-6.

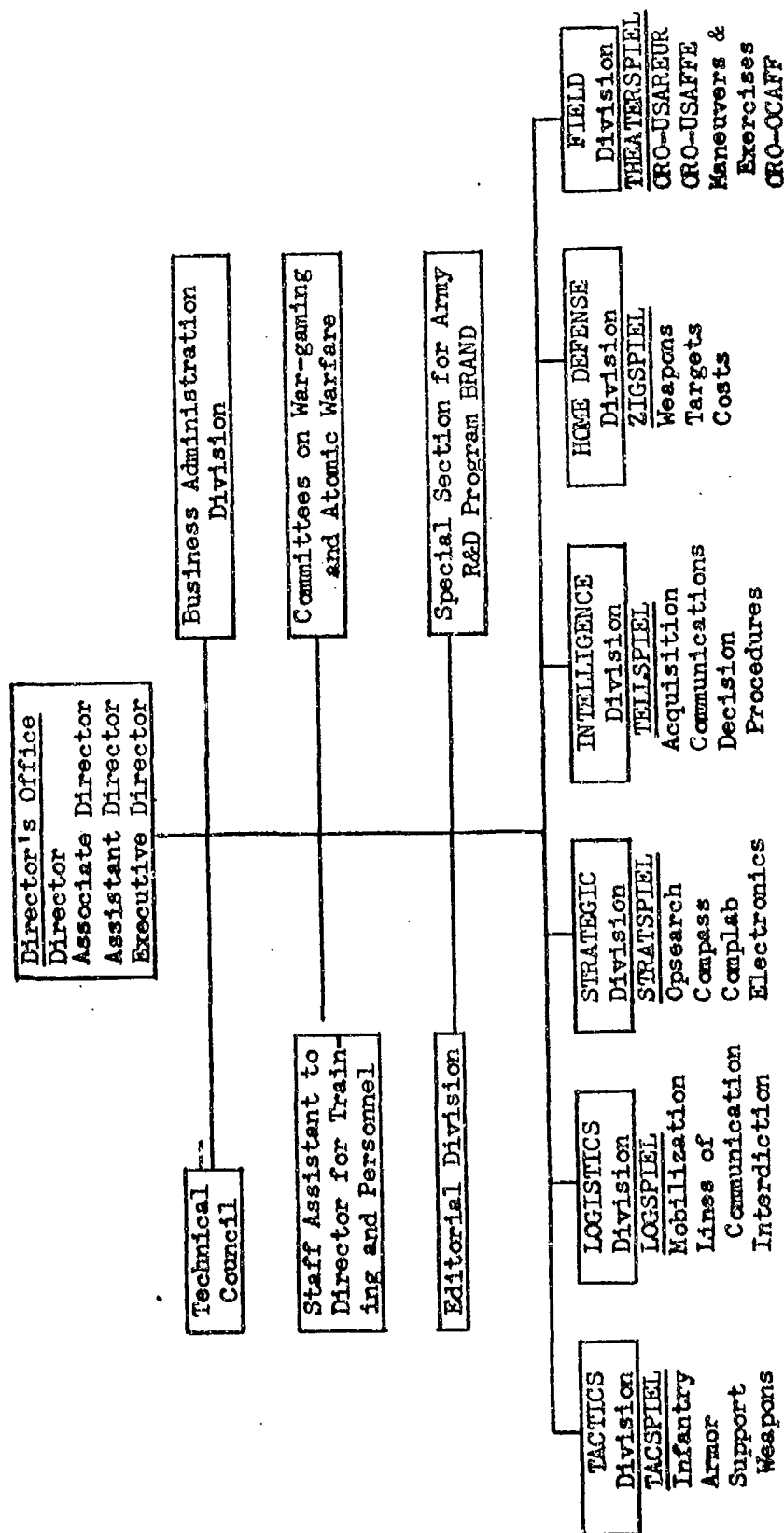


FIGURE 5

Operations Research Office Organization 1 April 1954

1) The tactical use of atomic weapons; how they would have affected actions in World War II; how they would affect actions in World War III; best systems for delivering atomic weapons present and proposed.

2) Defense against air attack.

3) Surface-to-surface guided missiles.

4) Mines and other anti-tank weapons.

5) The casualty saving potential of the helmet.

6) Analyzing the M-1 rifle and its effectiveness.

7) The effect of terrain on range.

8) The potentialities of air-to-ground rockets.

9) Methods and devices for improving intelligence.

10) Threats to our overseas lines-of-communications and ways of defeating them.³⁴

In 1954 the Operations Research Office had personnel working in several different areas of the world on many facets of the Army's research requirements. Scientific personnel were assigned to work with the Deputy Chief of Staff for Operations on the development of war plans. Permanent operations research groups were attached to the European and Far East Commands. These groups worked in advisory and data gathering capacities, and were in addition to the personnel that were in the Combat Operations Research Group with the Army Field Forces (later USCONARC).³⁵

In 1956 a follow-up study of the VISTA Report was conducted by a committee headed by Dr. Leland J. Haworth of the Army Scientific Advisory

³⁴Ibid., pp. 1-4.

³⁵Ibid., p. 5.

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development of operations research activities within the Army and associated operations research contract agencies. From its humble beginnings with the General Research Office (later the Operations Research Office) which was initiated to augment the research and development programs of the technical services, the Army organized or negotiated the development of many additional permanent operations research organizations including the Human Resources Research Office with its five Army Field Forces Human Research Units; the Combat Developments Group; the Combat Operations Research Group; the Combat Developments Experimentation Center; and the Special Operations Research Office. During this period there was a definite shift in emphasis in operations research from the relatively straight forward analysis of weapons to the more complex and less easily defined problems of strategy, tactics and the inter-relationship of the human being in the development and use of new systems and operations. The supporting research projects became more difficult to define and much broader in scope, tending to overlap into many different areas. This shift in emphasis on the research and development effort and the importance of operations research to this effort is summarized as follows: ". . . strategic needs can and ought to lead to tactical schemes and to new weapons designed to order."³⁸ However, it is essential that a proper mix of present day preparedness and phased obsolescence be maintained to keep cost and defense in balance. "The research and development (R&D) effort, therefore must be directed in the light of the most effective strategy and tactics, and it is a big part of the job of Army operations research to help the decision-makers determine what these are."³⁹

³⁸CRO Today, p. 5.

³⁹Ibid., p. 6.

CHAPTER V

CONTEMPORARY OPERATIONS RESEARCH

This is not the end. It is not even the beginning of the end.
But it is, perhaps, the end of the beginning.

Winston Leonard Spencer Churchill¹
(1874-1964)

The years 1960-1967, brought many changes in the type and number of Army in-house and Army associated organizations exp. ing operations research techniques. There was also some name changing and consolidation of effort by many agencies. The Army's research and development organization in effect during FY 60, including associated civilian operations research agencies, is shown in Figure 6. This organization, which emphasizes the agencies using operations research, reflects the increased interest of the Army in this scientific method.²

In 1960, the requirement for a large-scale in-house war gaming and planning group was recognized by the Department of the Army. The U. S. Army Strategy and Tactics Analysis Group (STAG) was created to satisfy this requirement. STAG was established in Bethesda, Maryland, under the control and supervision of DCSOPS. The mission assigned STAG was to support Department of the Army operational planning and evaluation activities by war gaming and allied operations research techniques. The

¹The Oxford Dictionary of Quotations (2d ed., London: Oxford University Press, 1955), p. 144.

²Harold S. Milton, Army Operations Research--FY 62 (Bethesda, Md.: Research Analysis Corp., PAC-TF-84, February 1963), pp. 7-18.

FIGURE 6 - Army Organization for Research and Development 1959³

3US Department of the Army, U.S. Army Organization and Procedures for Research and Development (Washington, D.C.: Prepared by the Chief of R&D, Department of the Army, January 1959), p. 3.

group was initially authorized a total strength of ninety-two personnel (forty-one military and fifty-one civilian). The civilians employed by STAG were to be primarily operations research analysts or mathematicians.³ STAG was functionally organized with an Administrative Office and three operating divisions, each with subordinate branches:

<u>Plans Division</u>	<u>Operations Division</u>	<u>Computer Division</u>
Personnel and Logistics Branch	Ground Combat Branch Gaming and Analysis Branch	Programming Branch
Operations and Intelligence Branch	Mathematical and Technical Branch	Computations Branch
		Display and Com- munications Branch ⁴

In December 1961, the Operations Research Office (ORO) was phased out and the Research Analysis Corporation (RAC), a non-profit research organization, was chartered to perform research for the U. S. government with emphasis on Army requirements. The Research Analysis Corporation received its projects from the various Army agencies through the Office of the Chief of Research and Development (OCRD). Headquarters for the corporation was established in Bethesda, Maryland. RAC retained most of the old ORO staff and assumed ORO's role as the primary operations research activity of the Army.⁵

Most of the remaining outside operations research effort of the

³US Department of the Army, Strategy and Tactics Analysis Group (STAG) (Washington, D.C.: Briefings for the Department of the Army Staff on 23-24 October 1961), Part I Narrative, pp. 1-11 of Col. DeQuoy's briefing, pp. 1-7 of Col. Lawing's briefing.

⁴Ibid., pp. 1-7 of Col. Lawing's briefing.

⁵Lynn H. Rumbaugh, A Look at US Army Operations Research--Past and Present (McLean, Va.: Research Analysis Corp., RAC-TP-102, April 1964), pp. 6-7.

Army was divided among four other permanent contract agencies: Human Resources Research Office (HUMRRO), Special Operations Research Office (SORO), Combat Operations Research Group (CORG) and Stanford Research Institute (SRI). There were also at least twenty in-house operations research groups in eleven Army commands and agencies. These in-house groups generally confined their efforts to specific study areas within the missions of their parent Army commands and agencies. They maintained their own scientific staffs of from two to forty personnel to conduct operations research projects; but they also contracted out many small studies to over twenty universities and private research organizations. These studies ranged from developing applications for automatic data processing to developing field army medical support systems.⁷ A summary of the Army in-house operations groups, the number of professional personnel they employed and the estimated annual cost of research conducted during FY 62 is contained in Table I.

Most of the contractual operations research organizations were quite centralized at this time and the Research Analysis Corporation was no exception. When RAC superseded CRO it consolidated many of the CRO activities. RAC initially retained CRO's field offices in Europe and Asia but later discontinued the office in Europe for a short time. In its home office, RAC established two research directorates:

Combat Systems--. . . concerned with weapons systems, communications, command and control, surveillance and target acquisition, combat organization and doctrine, tactics, mobility, agility, combat requirements and effectiveness criteria, technological forecasts and analyses of intelligence on friendly and enemy capabilities. In addition it conducts research into new methods in problem-solving and analysis, forming the basis for improved operations

⁷Rumbaugh, p. 6.

TABLE I

ARMY IN-HOUSE OPERATIONS RESEARCH GROUPS - 1962⁸

Sponsoring Agency	In-house group	Professional Personnel	Estimated Annual Cost, Thous of Dollars
MC	Combat Div Group	18	450
CMLC	OR Group	20	500
SIG	War Gaming Branch, Communications Dept	8	200
QMC	Operational Mathematics Office	4	100
TC	Combat Div Grp Materiel Cmd, Management Group	36	800
	Research Command, Mathematical Sciences Group	3	75
CE	Army Map Service, Strategic Planning Group	8	200
	Logistics Research and Planning Office	3	75
ORD	BRL Weapons Systems Div	40	1000
	Army Ordnance Missile Cmd	9	225
	Ordnance Weapons Cmd, OR Office	6	150
	Ordnance Tank and Automotive Cmd, Research Div	6	150
	Diamond Ordnance Fuze Lab	2	50
	White Sands Missile Proving Grounds	4	100
	Future Weapons Systems Agcy Aberdeen Proving Grounds	6	150
	Frankford Arsenal	5	125
	Picatinny Arsenal	3	75
CONARC	Ft. Sill	4	100
DCSOPS	STAG	18	450
Total		203	5075

⁸Milton, pp. 13-14.

research methods and techniques.⁹

Logistic and Management Systems--. . . deals with logistic war gaming, a broad range of economic and strategic studies, training and mobilization base, production base, maintenance, resupply, transportation, evacuation, intelligence as appropriate, inventory cycle costing, cost effectiveness, and budgeting.¹⁰

Other important elements of RAC were the Technical Support Units consisting of the Library, Editorial Department, and Electronics Laboratory which provided instrumentation for manual play and computer assisted war games and supported field experiments with instrumentation.¹¹

In 1961, a significant change was made in the Army in-house research and development structure. On 16 January 1961, the Office of Ordnance Research (which had been established during 1951 in association with Duke University, Durham, North Carolina) was transferred from the Chief of Ordnance to the Chief of Research and Development, Logistics Division, Department of the Army. The name of this organization was changed to the Army Research Office (ARO); and it was assigned the mission of administering the Army's basic research programs. A specific part of this program was the sponsoring of basic research in operations research methodology.¹²

The ARO sponsored the first Army-wide operations research symposium in March 1962. This symposium attracted many national and international operations research scientists and analysts. The operations

⁹Research Analysis Corporation, Scientific Problem Solving (Bethesda, Md.: Research Analysis Corp., 1963), pp. 4-8.

¹⁰Ibid., pp. 4, 5, 8, 9.

¹¹RAC, Scientific Problem Solving, pp. 14-17.

¹²US Department of the Army, Research in Progress 1961 (Durham, N.C.: U.S. Army Research Office, 1961), Foreword, pp. 2, 3.

research symposium has since become an annual event held at various Army combat development activities throughout the U. S. The objective of the symposiums is to assist the Army in maintaining an effective operations research program by:

- 1) Emphasizing the role of operations research as a method of improving military operations.
- 2) Familiarizing key personnel of the Army in Army operations research projects and capabilities.
- 3) Providing a scientific forum to present and discuss Army problems amenable to solution by operations research techniques.
- 4) Informing Army operations research analysts of new technological developments in the field of operations research.
- 5) Improving the applicability of results obtained from operations research studies by gaining outside scientific opinion.
- 6) Providing a means for Army operations research analysts to meet well-known national and international leaders in the field of operations research.¹³

To assist it in its tasks, ARO established the Operations Research Technical Assistance Group (ORTAG). This group had two specific missions: 1) to organize and supervise the annual operations research symposium sponsored by the Chief of Research and Development through the Army Research Office; and 2) to assist all other Army research and development elements in solving operations research problems--whether it was initiating the use of the system, obtaining skilled personnel, or solving

¹³US Department of the Army, U.S. Army Operations Research Symposium Proceedings 1962, Part I (Durham, N.C.: U.S. Army Research Office, March 1962), p. iii.

some particularly difficult problem in methodology.

Thus, in the 1960's the ARO became the official Army in-house sponsor of operations research. Creation of ARO provided a centralized agency to coordinate and contract out the basic research requirements of the Army to other research organizations such as RAC, SCRO, HUMPRO, etc. ARO also became a primary publishing agency for Army operations research publications. With the advent of the annual operations research symposium, ARO focused more attention on the use of all operations research activities both inside and outside of the Army.¹⁴

The Heescher Committee Report on Army research and development, which was completed during 1961, recommended the centralization and integration of all Army research and development effort. This recommendation led to the creation in July 1962 of the Combat Developments Command and the Army Materiel Command.

This change transferred the responsibility for research and development from USCOMARC, the technical services and the branch combat development centers to the newly organized Combat Developments Command (CDC). This command was charged with answering three questions:

- 1) How should the Army be organized?
- 2) How should the Army be equipped?
- 3) How should the Army fight?¹⁵

The change of research and development responsibility from COMARC

¹⁴US Department of the Army, U.S. Army Operations Research Symposium Proceedings 1964, Part I (Durham, N.C.: U.S. Army Research Office, May 1964), pp. 153-156.

¹⁵Harauld D. Laughan, LTC, Historical Summary, United States Army Combat Developments Command Experimentation Center, 1 Nov 1956--30 Jun 1964 (Ft. Ord, Calif.: U.S. Army Combat Developments Command Experimentation Center), Foreword, p. iii, p. 22; US Army Combat Developments Command, US Army Combat Developments Command Activation Plan, Vol. 1 (Ft. Belvoir, Va.: U.S. Army Combat Developments Command, 1 June 1962), p. 1.

to CDC did not materially affect the missions or work of either the Combat Operations Research Group (CORG), which was transferred in toto from CONARC to CDC; or the Combat Developments Experimentation Center (CDEC), which merely changed its name to Combat Developments Command Experimentation Center (CDCEC) and continued to work on previously assigned projects. However, looking to the future, CDCEC recommended that additional experiments assigned to CDCEC be problem oriented and support other CDC agency requirements. This accomplished two things--it insured the continued growth of CDCEC and provided the other combat developments agencies with an experienced experimentation agency to verify or refute conclusions generated by combat developments concept studies.¹⁶

Additional CDC agencies using operations research techniques were the combined arms groups co-located with eight service schools; the combat service support groups consisting of nine technical service elements; the Office of Special Weapons Development at Ft. Bliss, Texas; the Remote Area Conflict Office at the Special Warfare Center, Ft. Bragg, North Carolina, with liaison in Alaska and at the Jungle Warfare Center in the Panama Canal Zone; the Army Institute of Advanced Studies at Carlisle Barracks, Pennsylvania; and within the Headquarters of CDC--the Directorate for Operations Research and Experimentation, which was the Army supervisory agency for the Combat Operations Research Group (CORG).¹⁷ For a stripped organizational chart of the Combat Developments Command emphasizing the operations research related activities see Figure 7.

¹⁶Laughan, p. 30.

¹⁷US Army Combat Developments Command, US Army Combat Developments Command Activation Plan, Vol. 2 (Ft. Belvoir, Va., U. S. Army Combat Developments Command, 1 June 1962), pp. A-II-1, A-VI-3.

FIGURE 7

U. S. Army Combat Developments Command Organization 1962¹⁸

The mission of CDC's Directorate for Operations Research and Experimentation was:

To evaluate future operational and organizational concepts pertaining to the US Army through the application of scientific principles and methods. To direct and coordinate war gaming activities throughout the combat developments system and provide advice and assistance to other authorized agencies engaged in war gaming. To formulate requirements for troop tests and field experimentation in consonance with the Combat Developments Command mission. To arrange for and monitor such tests and experiments and to evaluate their results.¹⁹

The Combined Arms Groups were charged with the responsibility to:

Develop current and future operational and organizational objectives, doctrine and tactics; and materiel developments objectives and requirements for the combined arms and for combat and combat support elements of the Army in the field, exclusive of Army Group and higher, but inclusive of Theater Army air defense and unilateral Army operations and Army participation in joint operations, all in accordance with broad guidance provided by the Commanding General, US Army Combat Developments Command (CDC).²⁰

The mission of Combat Service Support Groups in the combat developments field was to:

Develop current and future operational and organizational objectives, doctrine, and tactics; and materiel development objectives and requirements for combat service support elements of the field army and communications zone, to include unilateral Army operations and Army participation in joint operations, all in accordance with broad guidance provided by the Commanding General, US Army Combat Developments Command (CDC).²¹

The Remote Area Conflict Office (RACO) was responsible for all combat developments activities relating to: unconventional warfare; psychological operations; counterinsurgency (including counter guerrilla) operations conducted by the U. S. Army and indigenous forces; and operations conducted by U. S. Army and indigenous forces in special environ-

¹⁹US, DA, USACDC Activation Plan, Vol. 1, p. A-I-F-2.

²⁰US, DA, USACDC Activation Plan, Vol. 2, p. A-II A-1.

²¹Ibid., pp. A-III-B-1, A-III-B-2.

ments such as jungle and arctic areas.²²

The Army Institute of Advanced Studies at the Army War College, Carlisle Barracks, Pennsylvania, was directed to prepare

. . . studies on broad international, national and departmental level matters affecting the requirements for land warfare. Develop broad tactical and logistical doctrine relating to the organization, employment, and strategic operations of the theater army and major subordinate elements above field army to include combined and joint operations.²³

The Office of Special Weapons Development (OSWD), Fort Bliss, Texas, was CDC's primary agency

. . . in the broad field of nuclear energy. OSWD will advise and assist USACDC and other US Army agencies in the development of objectives, concepts, requirements, doctrine, organization, and equipment as they pertain to the employment of and defense against nuclear energy by the army in the field, and in the doctrinal aspects of safety of army nuclear systems from conception to operational delivery or use; and upon request assist ZI Army Commanders in the planning and conduct of nuclear play in exercises.²⁴

The other major change caused by the reorganization of the Army research and development program was the creation in July 1962 of the Army Materiel Command (AMC). AMC did for the technical services materiel commands what CDC accomplished for the Army's combat developments activities. AMC centralized, consolidated and integrated the individual programs of the technical services to improve efficiency in materiel procurement, testing and evaluation. In accomplishment of these tasks AMC was assigned the following mission:

- 1) Direct, integrate, and improve performance of the wholesale materiel activities of the Army.
- 2) Furnish timely and effective supply support and maintenance support to the Army, to the Army elements of unified and specified commands,

²²Ibid., p. A-IV-D-1.

²³Ibid., p. A-V-1.

²⁴Ibid., p. A-VI-1.

and to other customers, as authorized.

3) Assist in the formulation of the Army materiel program, and implement the approved program in accordance with policy established by Department of the Army.²⁵

The Army Materiel Command fulfilled its assigned missions by: participating in the formulation of the Department of the Army materiel program; receiving and correlating funds and program authorities; allocating resources and program responsibilities; maintaining a policy of delegation of authority to subordinate commands; exercising control of subordinate activities through quantitative analysis of program performance and functional supervision of qualitative performance; and finally, using the project manager system for maximum direct-line control for projects which require this type of supervision due to their size or degree of specialization.

In AMC there were few readily identifiable operations research oriented offices or agencies; but there were many agencies using some of the techniques. A representative group of these are:

1) The Comptroller and Director of Programs which consisted of the Programs and Materiel Management Division, Plans Division and Review and Analysis Division. With the aid of these divisions the Comptroller and Director of Programs were responsible for quantitative review of the programs assigned CDC and making reports to higher Headquarters.

2) The Director of Research and Development was assigned the responsibility for:

a) Formulation of the overall AMC research and development program.

²⁵US Army Materiel Command, United States Army Materiel Command Activation Plan (Washington, D.C.: U.S. Army Materiel Command, 16 July 1962), Cover Letter, p. 1.

- b) Direct supervision and control of assigned laboratories.
- c) Supervision of research and development activities of subordinate commands.
- d) Supervision of assigned test facilities.
- e) Quantitative and Qualitative review of performance of all these activities.
- f) Monitor development activities in Special Warfare.

To accomplish these tasks the directorate was sub-divided into a Plans and Programs Branch, Review and Analysis Branch, Test and Evaluation Branch, Special Warfare Branch, and Scientific Personnel Management Branch. This directorate also exercised supervision over the Ballistics Research Laboratories, Human Engineering Laboratories, Diamond Fuze Laboratories, General Supplies Research and Engineering Laboratories, Materials Research Agency and Cold Regions Research and Engineering Laboratory.

3) In addition to these directorates many other AMC activities used operations research techniques in their analyses, evaluations and reports.²⁶

The Management Science Office of AMC, which was charged with evaluating and integrating existing technical service management techniques and developing improved methods and techniques, was the only office in AMC that had a specific operations research mission.²⁷

The Army was not the only organization undergoing changes. Both the Research Analysis Corporation (RAC) and the Special Operations

²⁶Ibid., pp. 2-7, A-89 through A-110.

²⁷Ibid., pp. 46, A-85 through A-88.

Research Office adjusted their organization to more effectively solve the research problems assigned to them.

In 1963, the Research Analysis Corporation (RAC) added another directorate to its organization, the Systems Engineering Directorate. This directorate had the mission of taking part

. . . in long term technical planning and forecasting; to examine critically officially-stated hardware requirements from a technological standpoint; to develop new ideas for Army hardware programs; to evaluate current Army development programs from a technological standpoint; and to evaluate present field equipment.²⁸

In an effort to overcome the limited quantity of current field data available for use by its analysts, RAC established additional field research offices. An enlarged field office was developed in Southeast Asia with branches in Seoul, Korea; Saigon, South Vietnam; and Bangkok, Thailand. In addition a field office was re-established in Europe at Headquarters, Seventh Army, Stuttgart, West Germany. The addition of these field offices provided RAC with a better means of obtaining the data generated by the field forces. These field offices also provided RAC with a means of using the field forces of the Army to support the research requirements of the Army as a whole. The data collected by these offices appreciably offset the severe lack of current combat data; but the most significant accomplishment was getting the analyst out from behind his desk and into the field.²⁹

Reviewing some of the more recent successes of Army operations research, RAC noted that operations research had played a major part in the decision to develop tactical nuclear weapons at a time when only the

²⁸RAC, Scientific Problem Solving, pp. 4, 5, 10.

²⁹Ibid., p. 11; Rumbaugh, p. 17.

strategic nature of these weapons was understood. Continued research in this area led to the development of a whole family of yields and delivery means. Operations research analysis also provided a basis for deciding how many of what types of war heads should be produced and suggested the best defenses against this type of weapon. Other areas bearing the stamp of operations research analysis are: research and development programs, deployment plans, maintenance requirements of surface-to-air missiles and surface-to-surface missiles, counterguerrilla case studies, and field analyses in actual operational theaters.³⁰

The operations research interests of RAC in 1963 were not much different from the interests of its predecessor the Operations Research Office. In a summary of RAC/ORO topics for the preceeding thirteen years (see Table II) it was found that there were few major changes in the types of projects assigned. However, there had been a gradual decrease (forty-seven per cent to thirty-nine per cent) in publications on combat operations and a corresponding increase (twenty-one per cent to twenty-nine per cent) in publications on logistics and costs. There was also a modest increase (two per cent to seven per cent) in publications on operations research methodology. RAC noted that the reduction of publications on troop training and psychological warfare was due to the development of the Human Resources Research Office (HUMRRO) and the Special Operations Research Office (SCRO).³¹ See Table II for a summary of U. S. Army major contract effort by subject and study topic.

This shift in topic emphasis within ORO/RAC was accompanied by a

³⁰RAC, Scientific Problem Solving, p. 17.

³¹Rumbaugh, p. 7.

TABLE II
 PERCENTAGE DISTRIBUTION OF TOPICS IN ORO SEMIANNUAL REPORTS
 JULY 1948 - JUNE 1961, BY SUBJECT³³

Study Topic	Jul 48- Jun 51	Jul 51- Jun 54	Jul 54- Jun 58	Jul 58- Jun 61	Weighted 13-yr avg
	Percent				
<u>Combat Operations Requirements</u>					
Troop strengths, or- ganization, doctrine and tactics	7	10	15	11	12
Weapons and effects	25	18	19	18	19
Combat equipment and vehicles	11	7	8	6	8
Intelligence inter- pretation and theory of procedure	4	6	3	4	4
<u>Total</u>	47	41	45	39	43
<u>Logistics and Costs</u>					
Logistics operations	9	3	6	8	6
Support logistics	6	5	6	10	7
Production and costs	6	9	12	11	10
<u>Total</u>	21	17	24	29	23
<u>Combat and support total</u>	68	58	69	68	66
<u>Background Studies</u>					
Social, cultural, civil affairs environment	4	7	3	3	4
International (strategic, economic and political)	8	4	3	7	5
<u>Total</u>	12	11	6	10	9
<u>General Studies</u>					
Selection, training and performance	7	9	3	2	5
Psychological warfare	7	8	4	-	5
Special warfare	-	4	3	1	3
<u>Total</u>	14	21	10	3	12
<u>Special Studies</u>					
R & D Management	4	2	6	8	5
Methodology	2	3	5	7	5
Miscellaneous	-	5	4	4	3
<u>Total</u>	6	10	15	19	13

³²Rumbaugh, p. 9.

TABLE III
PERCENTAGE DISTRIBUTION OF US ARMY OR EFFORT BY SUBJECT AND STUDY TOPIC³³

Study Topic	Army OR Contracts			
	RAC Only		All Contracts	
			OR and Analyses	
	1951-1954 ^a	1963 ^b	1962-1963 ^c	1962-1963 ^d
Percent				
<u>Combat Operations</u>				
Troop strengths, organization, doctrine and tactics	10	16	18	16
Weapons and effects	18	9	6	8
Combat equipment and vehicles	7	7	4	12
Intelligence interpretation and theory of procedure	6	1	3	3
<u>Total</u>	41	33	31	39
<u>Logistics and Costs</u>				
Logistics Operations	3	16	8	7
Support logistics	5	6	3	5
Production and costs	9	15	6	7
<u>Total</u>	17	37	17	19
<u>Combat & Support Total</u>	58	70	48	58
<u>Background</u>				
Social, cultural, & environmental	7	1	8	6
International (strategic, economic, & political)	4	8	7	5
<u>Total</u>	11	9	15	11
<u>General</u>				
Selection, training & performance	9	-	21	17
Psychological warfare	8	-	3	3
Special Warfare	4	8	7	6
<u>Total</u>	21	8	31	26
<u>Special</u>				
R & D Management	2	5	2	2
Methodology	3	7	4	3
<u>Total</u>	5	12	6	5

^aBased on publications; estimated total technical personnel 110.

^bBased on personnel; estimated total technical personnel 170.

^cBased on personnel and dollars; estimated total technical personnel 480.

^dBased on personnel and dollars; estimated total technical personnel 590.

³³Ibid., p. 16.

change in the disciplines of the technical personnel. Initially most of these personnel were mathematicians and physical scientists; but by 1953 over forty per cent were from fields related to economics, human arts and human sciences. In 1963, there were still forty per cent from the humanities but the percentage of economists rose while the human scientists decreased. Correspondingly, an increase in the percentage of mathematicians and statisticians was off-set by a decrease in the percentage of engineers and physical scientists. Throughout this entire period the percentage of natural scientists remained relatively constant. As the other permanent contract groups (HUMRRO, SORO, CORG, and SRI) were developed to satisfy special requirements, some of the research effort was transferred from ORO/RAC. This shift in work programs caused changes in the type of technical staff retained by each organization. By 1963 the nature of the work conducted by each of the contractors was a significant influence on the technical personnel they employed, for example: over ninety per cent of the economists in the Army contract operations research agencies were employed by RAC; over eighty per cent of the psychologists were at HUMRRO; and two-thirds of the political scientists were with SORO. All of these organizations suffered from a significant lack of trained operations research analysts because the demand in the other military services, the government and civilian industry greatly exceeded the supply.³⁴ See Table IV for a summary of the 1963 distribution of operations research personnel by original discipline.

SORO went through a series of reorganizations and expansions and contractions during the period 1963-66. For example SORO established the

³⁴Ibid., p. 7.

TABLE IV
DISTRIBUTION OF OR PERSONNEL BY ORIGINAL DISCIPLINES^{34A}

Subject	ORO-RAC		Five Army Contractors ^a
	1953 ^b	1963 ^c	1963 ^d
	Percent		
<u>Mathematics & Physical Sciences</u>			
Mathematics and Statistics	8.1	19.0	14.1
Engineering	19.8	16.1	10.2
Physics	16.2	11.3	5.3
<u>Natural Sciences</u>			
Chemistry	4.5	4.1	1.7
Earth Sciences	2.7	4.1	1.7
Biology	0.9	1.2	0.5
Physiology	1.8	0.6	0.7
Botany	0.9	1.2	0.7
Anthropology	0.9	---	2.0
<u>Humanities</u>			
Economics	7.3	13.7	6.1
Business	---	3.6	2.7
Psychology	8.1	3.0	29.7
Political Science	9.9	7.1	8.8
History	9.9	6.0	4.1
Sociology	1.8	1.2	2.0
Literature, Language and Law	3.6	1.8	3.9
<u>Miscellaneous</u>			
Philosophy	1.8	1.8	0.7
Military Science	1.8	4.2	2.9
Operations Research Analyst	---	---	2.2

^aRAC, HUMPRO, SCRO, CORG, SRI.

^bTotal personnel, 111.

^cTotal personnel, 169.

^dTotal personnel, 411.

^{34A}Ibid., p. 8.

Counterinsurgency Information Analysis Center (CINFAC) in order to satisfy a requirement identified by the 1962 Joint DOD/CIA Committee on Counterinsurgency Research and Development for the "... establishment of a rapid response system which can effectively store and retrieve raw data as well as completed studies on counterinsurgency." CINFAC was assigned the mission of providing the Army and other Department of Defense agencies with a rapid response system for collecting, storing, retrieving and analysis of information on peoples and cultures of the world as they apply to insurgency settings.³⁵

Another agency established by SORO during this same period was the Scientific Advisory Service (SCADS), which was developed to provide immediate advice to the Army. These advisory services included brief studies outside the programmed work of SORO, assistance in implementing SORO research findings and assistance in the preparation of social science information oriented reports. In its role of directing Army research and development, the Office of the Chief of Research and Development was given the responsibility of approving all SCADS projects.³⁶

SORO also developed several field support activities by setting up research offices near operating field forces. The field office at Ft. Bragg, North Carolina, was established in March 1963, to provide a research capability and maintain liaison with the social science community. The field office in the Panama Canal Zone was established during February 1964, to conduct "... social science research on problems of

³⁵Special Operations Research Office, SORO R&D Work Program FY65 (Washington, D.C.: Special Operations Research Office, The American University, 1 July 1964), pp. 11, 111.

³⁶Ibid.

understanding affecting or supporting foreign peoples and societies, especially in Latin America, who were involved in or threatened by insurgency and subversion."³⁷ The field office established in Korea also during February 1964 had its offices in Seoul with the Korean research units of HUMPRO and RAC. The mission of the SCRO field office in Korea was to satisfy the Army's operational needs in the fields of cross-cultural communications, military assistance and community relations. These field offices provided an essential source of data to support and augment the research accomplished at the home offices.³⁸

These changes in SCRO resulted in a re-definition of SCRO's mission making it responsible for the conduct of :

. . .non-materiel research in support of Department of the Army's missions in such fields as counterinsurgency, unconventional warfare, psychological operations and military assistance programs.³⁹

SCRO was assigned three specific tasks within the scope of this mission:

- 1) to develop recommendations for doctrinal guidance in the conduct of various counterinsurgency operations.
- 2) To provide basic educational materials appropriate to these recommendations when approved.
- 3) To develop specific area/country guide books in support of Army overseas operations.⁴⁰

In July 1966, the research and development portion of the Special Operations Research Office (SCRO) mission was transferred to a new

³⁷Ibid., p. 36.

³⁸Ibid., pp. 36, 37, 39.

³⁹Ibid., pp. ii, iii.

⁴⁰Ibid.

organization, the American University Center for Research in Social Systems (CRESS). This center presently consists of two component institutes designed to bring specialized professional talent to bear on specific social science research, development, study and service problems in the international and public affairs fields. These two institutes are:

1) Social Science Research Institute (SSRI)--which conducts social science research to support Department of the Army missions in the fields of counterinsurgency, unconventional warfare, psychological operations, military assistance programs, and studies and evaluations of foreign cultures.

2) The Cultural Information Analysis Center (CINFAC)--provides informational support for the Army and other DOD activities.⁴¹

The Army had made much progress since World War II in adopting and adapting operations research to assist it in its research and development program. However, most of this effort had been restricted to civilian scientists employed by the Army and associated civilian contract agencies. Very little effort had been made by the Army to disseminate general knowledge of the method or to maximize its use throughout the Army. A step was taken to correct this error with the initiation of the operations research symposiums conducted by the Army Research Office. However, these symposiums still were not the whole answer because they were directed primarily at the Department of the Army General Staff and those elements of the Army executing the Army's research and development program.

⁴¹Center for Research in Social Systems, Work Program Fiscal Year 1967 (Washington, D.C.: Center for Research in Social Systems, The American University, 1 August 1966), pp. iii, iv.

Another approach to solving this problem of increasing the understanding and use of operations research in the Army came about as a result of the Haines Board. This board was commissioned in 1965, to review and report their findings on the Army Schools System for Officers. This report, which was published in February 1966, made many specific recommendations to improve the officer schools. Some of these recommendations dealt with the improvement of the operations research posture of the Army.

In its report, the Haines Board noted the development of operations research and its increased use within the Department of Defense. But the Board also noted that Congress had become disturbed over the increased costs involved in supporting more and more operations studies. These conflicting facts made it clear to the Board that the Army must make maximum effective use of all funds authorized for operations research studies. One means of accomplishing this was to properly train the necessary military specialists to fill positions calling for graduate training in operations research and simultaneously develop understanding of the method throughout the Army.

The study concluded that for FY65 there were 116 Army Educational Requirements Board (AERB) validated positions requiring graduate degrees in operations research or systems analysis. This was double the requirement for FY 64. In late 1964, an informal Systems Analysis Specialist Program was established to identify qualified personnel and coordinate their assignment to operations research/systems analysis positions. As of November 1964, 109 officers, including sixty colonels/lieutenant colonels, thirty-nine majors and ten captains, most of whom had graduate degrees in operations research or systems analysis, were

participating in the specialist program.⁴²

In addition to this small pool of specialists the Haines Board found that in the year 1965, officers could participate in four types of operations research/systems analysis oriented training programs: instruction included in officer career and specialist courses in Army schools; participation in other service, defense and government courses; graduate schooling in civilian colleges and universities; and on-the-job training. Each of these training programs except on-the-job training will be explained in more detail below:

1) Army Career and Specialist Courses:

a) USMA conducts five principle courses (two more offered beginning school year 1966). Offers eight associated courses as electives.

b) Basic Courses at the present time offer no instruction.

c) Career (Advanced) Courses offer operations research/systems analysis instruction of from three to thirteen hours conducted in the Infantry, Signal, Chemical, Transportation, Military Police, Women's Army Corps and Medical Schools.

d) Command and General Staff College devoted only three hours to this instruction; but by 1966 this was increased to nine hours.

e) The Army War College had about twelve hours of operations research/systems analysis principally concentrated in a four day Command Management Seminar which included the theory and principles of decision-making, techniques of operations research/systems analysis and war gaming concepts.

⁴²US Department of the Army, Report of the Department of the Army Board to Review Army Officer Schools, Vol. III (Washington, D.C.: Department of the Army, February 1966), pp. 593-604.

f) The U. S. Army Logistics Management Center conducts no specific operations research/systems analysis courses but principles of the method as they apply to logistics were taught within the scope of the other courses.

g) The U. S. Army Management Engineering Training Agency conducted six courses of from one to six weeks duration on operations research/systems analysis.⁴³

2) Other service, defense and government courses were available for Army use in 1965:

a) Graduate degree level courses at the Naval Postgraduate School, Air Force Institute of Technology, and the Institute of Defense Analysis (IDA). As of 1965, fourteen Army officers were attending these courses.

b) The Civil Service Commission and several other government agencies sponsor short operations research/systems analysis orientation courses of from one day to eight weeks.⁴⁴

3) Graduate Civil Schooling. In 1965, civilian operations research/systems analysis graduate degree programs were offered in at least fifteen U. S. universities. At that time twenty-one Army officers were enrolled in seven of these universities. This enrollment constituted a fifty per cent increase over the total number of Army officers receiving Army-sponsored degrees in the field during the preceding ten years.⁴⁵

After analyzing all these facts the Haines Board arrived at the following conclusions relative to the condition and development of oper-

⁴³Ibid., pp. 595-597.

⁴⁴Ibid., p. 596.

⁴⁵Ibid., pp. 595-597.

ations research and systems analysis in the Army:

- 1) Three levels of OR/SA officer training and education should be established: specialist, executive level, and familiarization.
- 2) The Systems Analysis Specialist Program should be established as a formal program under the direction of the Deputy Chief of Staff for Personnel in coordination with the Assistant Chief of Staff for Force Development.
- 3) Position requirements in SA Specialist Program in the grades of captain and major should be increased to provide program balance and an adequate junior officer base to support validated senior positions filled on a reutilization basis. An annual input of approximately 60 officers in junior grades into graduate schooling in OR/SA would meet estimated requirements.
- 4) For the OR/SA education of specialists, advanced degree courses tailored to Army requirements should be established at a limited number of civilian universities. To supplement this graduate schooling, on-the-job training programs should be developed with selected contract research agencies.
- 5) For OR/SA executive level training, the branch career (advanced) course, C&GSC, and Army War College should adopt a progressive elective program for approximately 20% of students in the combat arms and technical services.
- 6) For OR/SA familiarization training, branch-oriented instruction should be conducted as part of the career (advanced) course. At least eight hours should be devoted to this subject in courses of the professional and administrative branches and 24 hours in those of the technical services and combat arms. Students at the C&GSC and Army War College should receive approximately 24 hours of OR/SA training in each course.
- 7) The C&GSC should be the proponent agency for OR/SA instruction in Army Schools.⁴⁶

Based upon these conclusions several changes were proposed in the Army Officer School System for succeeding years. The operations research/systems analysis subjects in the course curriculums were to be increased at many of the branch career courses, at the technical service schools and at C&GSC.⁴⁷ An operations research/systems analysis

⁴⁶Ibid., pp. 603-604.

⁴⁷Ibid., pp. 597-603.

specialist program was adopted by Department of the Army in FY67 and an immediate effort was made to train more personnel in these fields.⁴⁸ One means of increasing the number of specialists was to immediately expand the one year Defense Systems Analysis Program, which was developed in August 1965 by the Institute for Defense Analysis in Arlington, Virginia. This course was offered in coordination with the University of Maryland and leads to a degree of Master of Arts in Economics. The first class in 1965 consisted of thirty students: twenty-four military and six civilians. Later classes were expanded to sixty students.⁴⁹

To summarize Army operations research for the period 1960-1967 is to recognize the increased importance of the method to the execution of the Army research and development program. During this period there were many changes in Army organization and in the organization of the various associated contract agencies. The oldest of the Army's contract agencies--the Operations Research Office (ORO) was replaced with the Research Analysis Corporation (RAC). The Special Operations Research Office (SORO) reorganized its activities, gaining additional responsibilities with the initiation of the Scientific Advisory Service (SCADS) and the Counterinsurgency Information Analysis Center (CINFAC) and losing the research and development segment of its mission to a new contract agency, the American University Center for Research in Social Systems (CRESS). All of the Army contract agencies underwent a gradual but significant shift in the type of technical personnel they employed

⁴⁸This information is based upon conversations with representatives of OPO-Armor, Adjutant General, Department of the Army.

⁴⁹E. J. Ortlieb, CMDR, USN, "Defense Systems Analysis Program," United States Naval Institute Proceedings, August 1966, pp. 52-60.

as the projects they were assigned became more specialized. During 1962 the Army reorganized its research and development effort into two large commands, the Combat Developments Command (CDC) and the Army Materiel Command (AMC). CDC had many more activities using all aspects of operations research than AMC because of the conceptional nature of its work; but AMC also used operations research throughout its organization to assist it in properly managing its tasks of procurement, testing and evaluation. Although the use of OR had spread appreciably in both the military and civilian scientific communities by 1965, the Army still did not have a wide base for in-house operations research. The creation of the Army Research Office (ARO) to coordinate the Army's requirements for basic research including operations research and the initiation by ARO of the annual operations research symposium only partially solved the problem. This deficiency in operations research training was noted by the Haines Board in its report on the Army Officer School System. The board concluded that a specialist program should be initiated and that operations research/systems analysis training should receive more emphasis in Army career (advanced) courses, technical schools and at the Command and General Staff College.

CHAPTER VI

FORECAST FOR THE FUTURE

Old men and comets have been revered for the same reason; their long beards, and pretences to foretell events.

Jonathan Swift¹
(1667-1745)

Predicting the exact future of operations research is difficult. The method has proved very effective in both military and government applications. Since his assumption of office in 1961, Secretary of Defense Robert S. McNamara has restructured the entire upper echelons of the military establishment--centralizing planning, programing, budgeting and procurement. The success of this program influenced the remaining government agencies which under a 1965 presidential order began introducing PPBS (planning-programing-budgeting system) into their operations.² It can be anticipated, that as the techniques of the method become more accepted and understood, the procedures will spread to succeeding lower echelons as proficiency and applications increase.

The success of these programs haven't been lost on the civilian community. Since the end of World War II more and more attention has been focused on developing civilian applications especially in industry and business. Recently, the civilian scientific and industrial

¹The Oxford Dictionary of Quotations (2d ed., London: Oxford University Press, 1955), p. 520.

²Max Ways, "The Road to 1977," Fortune, Vol. LXXV, No. 1, January 1967, pp. 93-95.

communities have taken the position that through the use of scientific analysis that the U. S. and the world can finally come to grips with and predict the future with some confidence. This new look is achieved by the stimulation of ideas and by properly developing alternatives so that the decision-maker has a better means of measuring the results against the objectives and costs. This new group of intellectuals called the "futurists" is typified by Henry S. Rowen, president of the Rand Corporation and formerly an assistant director in the Bureau of the Budget; Stephen R. Graubard, editor of Daedalus, who heads an American Academy of Arts and Sciences study group on the year 1976; and Daniel Bell, head of the Columbia College Department of Sociology, chairs a group--Commission on the Year 2000, which is also sponsored by the American Academy of Arts and Sciences. These futurists believe that this new attitude and approach to problem-solving will be soon recognized world-wide as being typically American.³

Within the Army the Chief of Staff has led the way in anticipating the influence and importance of operations research and associated systems to the Army. In February 1967, he directed the establishment of an Office, Assistant Vice Chief of Staff in the Office, Chief of Staff in order to be able to integrate all in-house analysis efforts.

The areas of interest of this new office are:

- 1) Management Information Systems - which prescribe the approach to measurement and analysis of requirements and availability of resources in relation to plan or program and provide for a massive data reduction and analysis in order to surface, at the earliest possible time, potential problem areas for management attention.
- 2) Weapons Systems Analysis - measures alternative solutions to the mix of personnel, forces, logistical support and funds.

³Ibid.

- 3) Force Planning Analysis - compares alternative forces and their costs against mission capabilities.⁴

The goal of the Chief of Staff in this reorganization was to achieve a high degree of integration of the technical, administrative and management talent of the Army into a management system that is auditable, economical and responsive to change. General Johnson established a two year time limit for the accomplishment of this goal. The implementation of this program calls for the development of four directorates:

1) Director of Studios - supervises long range studies. Resources for this directorate will be drawn from the Office, Director of Special Studies.

2) Director of Management Information Systems - coordinates, guides, and controls the development of Department of the Army information and data systems to insure the timely receipt of information. A major element of the mission of this directorate is the development of techniques and equipment to correlate and display meaningful data to assist in determining management problem areas.

3) Director of Weapon Systems Analysis - prescribes guidance and monitors analyses to identify weapon systems alternatives, the resources necessary to carry out the alternatives and what actions are required to achieve the preferred alternatives. This directorate is designed to answer the following questions:

- a) Which weapon system or weapon systems mix can best meet a given threat or set of threat scenarios?
- b) At what point in time is the introduction of a new system justified?

⁴US Department of the Army, Reorganization of the Office Chief of Staff (Washington, D.C.: Office of the Chief of Staff, CS320, Memorandum from the Chief of Staff for the Heads of Army Staff Agencies, 16 February 1967), pp. 1-3.

c) At what point in time can the system currently operational be justifiably replaced?

d) What are the key aspects of performance and/or characteristics that particularly justify its existence?⁵

4) Director of Force Planning Analysis - performs two major

functions:

a) The translation of OSD . . . decisions into specific program direction in terms of forces and resources.

b) The use of automated analytical models for the rapid assessment of alternative force structures and their associated costs.⁶

The completion of this program should provide a centralized effort in the field of management that will materially assist the Army in achieving its ultimate objective of fielding and supporting any required mix of forces to meet any requirement placed upon it.⁷

With the Department of Defense emphasis on centralized planning-programming-budgeting-procurement, the Army's requirements for men and materiel plus the tactics and strategies they must serve are carefully analyzed for validity before being approved. This new integration of management effort by the Army will go a long way toward assisting the Army in preparing its future requirements and providing a basis for supporting these requests when they are presented to the Defense Department and Congress.⁸

However, this centralization can be ordered and undertaken but the desired results can not be achieved without properly trained personnel

⁵Ibid., Incl 1 to Incl 1, Incl 2.

⁶Ibid., Incl 2 to Incl 2.

⁷Ibid., pp. 1-4, Incl 1 w/3 incl, Incl 2 w/2 incl.

⁸Special Force Planning, Annual Report, United States Army, 1964, pp. 54-56.

to man the system. Increased emphasis by the Army in training its officer personnel in operations research/systems analysis will provide the necessary background and expertise to support centralization of manpower, management and expansion of operations research technical knowledge throughout the Army. As this talent becomes more widely dispersed in the Army, operations research should influence many new areas of Army operations. See Figure 8 for the current and proposed Army research and development organization as of 1 April 1967.

The in-house segment of the Army operations research/systems analysis training, which in the long run will provide the greatest impact on the Army as a whole, is presently undergoing revision. In accordance with the recommendations of the Haines Board, the Command and General Staff College (C&GSC) has sponsored a program to expand the OR/SA training being conducted in the Army schools. The program as planned will consist of fifty-one hours of instruction. Twelve hours will be taught at C&GSC during 1967-1968. Copies of lesson plans for the nine hours taught at C&GSC during 1966-1967 were forwarded to service schools in February 1967. Forty hours of this instruction is being prepared by a contractor, and will be forwarded to the service schools in October 1967. Thirty-nine of these hours will be offered as electives at C&GSC beginning in 1968. C&GSC estimates that within four or five years, when the OR/SA oriented service school graduates begin arriving at C&GSC, the OR/SA course of instruction will need modification and expansion based upon the assumption that student officers will have the basics.⁹

⁹US Command and General Staff College, Instructional Packet for Common Subjects Modern Analytical Methods (Operations Research/Systems Analysis) (Ft. Leavenworth, Ks.: Command and General Staff College, April 1967), p. 3.

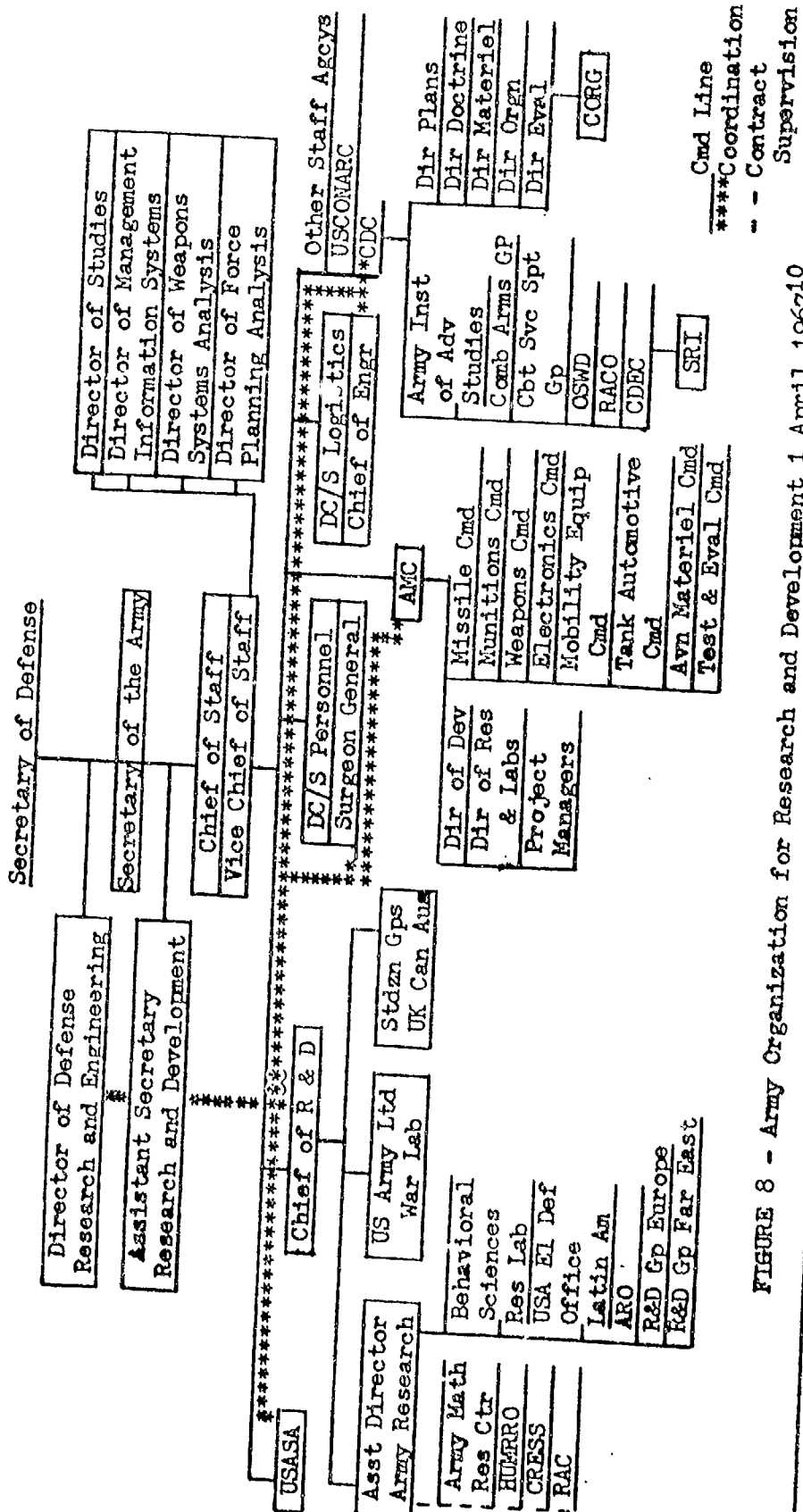


FIGURE 8 - Army Organization for Research and Development 1 April 1967¹⁰

¹⁰US Department of the Army, U.S. Army Research & Development Organization (Washington, D.C.: Chart prepared by Programs and Budget Division, Office of the Chief of Research and Development, 1 April 1967); DA Reorganization of the Office, Chief of Staff, Incl. 4; US Army Combat Developments Command, Organization and Functions (Ft. Belvoir, Va.: US Army Combat Developments Command, September 1966), pp. 4-89.

In the future, there may very well be a system or systems to supercede operations research; but it is probable that the techniques of operations research will be the heritage of any similar system. The primary role of operations research should continue its evolution from the simple two-dimensional problems of the past to complex interaction problems of the future. The principal limitation of military operations research in the Army today is the need for greater understanding of the system and training in the techniques. However, the increased use of operations research/systems analysis both inside and outside the military will speed the development of new methodology and devices. Increased emphasis in education of the Army officers will improve the posture of the Army in the field of operations research in combat, combat support, combat service support and research and development. As the effect of this increased emphasis becomes felt, the techniques will be applied in ever-widening spheres affecting more types of Army operations. I also feel that the education and training in operations research developed by the Army will not be wasted no matter what happens to the method, because there is always a requirement for systematic appraisal, planning, and the application of common sense in military activities.¹¹ And finally, I conclude that operations research teaches the user to scientifically employ his faculties:

(To find)¹² with keen discriminating sight
Black's not so black; - nor white so very white.

George Canning¹³
(1770-1827)

¹¹Stillman.

¹²Author's substitution--exact quotation reads "And finds."

¹³The Oxford Dictionary of Quotations, p. 124.

BIBLIOGRAPHY

Books

- Ackoff, Russell Lincoln and Rivett, Patrick. A Manager's Guide to Operations Research. New York: Wiley, 1963.
- Ackoff, Russell Lincoln with collaboration Gupta, Shiv K. and Minas, Sayer J. Scientific Method: Optimizing Applied Research Decisions. New York: Wiley, 1962.
- Barish, Norman N. Systems Analysis for Effective Administration. New York: Funk & Wagnalls Co., Inc., 1951.
- Barnes, G. M., MG, USA (Ret). Weapons of World War II. New York: D. Van Nostrand Co., Inc., 1947.
- Batchelor, James H. Operations Research, An Annotated Bibliography. 2d ed. St. Louis: St. Louis University Press, 1959.
- Baumol, William J. Economic Theory and Operations Analysis. 2d ed. Englewood Cliffs, N.J.: Prentice Hall, 1965.
- Baxter, James Phinney, 3d. Scientists Against Time. Boston: Little, Brown and Co., 1948.
- Churchman, Charles West. Introduction to Operations Research. New York: Wiley, 1957.
- Dupree, A. Hunter. Science in the Federal Government. Cambridge, Mass.: The Belknap Press of Harvard University Press, 1957.
- Eggleston, Wilfrid. Scientists At War. London: Oxford University Press, 1950.
- Fraser, C. E. and Teele, S. F. Industry Goes to War. 1st ed. New York: McGraw-Hill Book Co., Inc., 1941.
- Green, C. M., Thomson, Harry C., and Roots, Peter C. United States Army in World War II, The Technical Services, The Ordnance Department: Planning Munitions for War. Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1955.
- Handlin, Oscar, et al. Harvard Guide to American History. Cambridge, Mass.: The Belknap Press of Harvard University Press, 1963.

- Hooker, Robert. Introduction to Scientific Inference. San Francisco: Holden-Day, Inc., 1963.
- Jervis, Jervis-White, Captain, M. P. Engines of War and How We Got to Make Them. London: Chapman and Hall, 1859.
- Lacey, Oliver L. Statistical Methods in Experimentation. New York: The MacMillan Co., 1953.
- Le Breton, Preston P. and Henning, Dale A. Planning Theory. Englewood Cliffs, N.J.: Prentice Hall, Inc., 1961.
- Leighton, Richard M. Management Control in the Army Service Forces. Washington, D.C.: Office of the Chief of Military History, Department of the Army, January 1951.
- McCloskey, J. F. and Trefethen, F. N. Operations Research for Management. Vol. 1. Baltimore: the Johns Hopkins Press, 1954.
- Miller, David W. and Starr, Martin K. Executive Decisions and Operations Research. Englewood Cliffs, N.J.: Prentice Hall, 1960.
- Miller, Robert W. Schedule, Cost and Profit Control with PERT. New York: McGraw-Hill Book Co., Inc., 1963.
- Morse, Philip McCord and Kimball, George E. 1st ed. revised. Methods of Operations Research. New York: Wiley, 1951.
- The Oxford Dictionary of Quotations. 2d. ed. London: Oxford University Press, 1955.
- Price, Don K. Government and Science. New York: New York University Press, 1954.
- Risch, Erna. United States Army in World War II, The Technical Services, Quartermaster Corps: Organization, Supply and Services, Vol. 1. Washington, D.C.: Office of Chief of Military History, Department of the Army, 1953.
- Sasieni, Maurice. Operations Research: Methods and Problems. New York: Wiley, 1965.
- Shaffer, L. R., Ritter, J. B., and Meyer, W. L. The Critical Path Method. New York: McGraw-Hill Book Co., 1965.
- Stewart, Irvin. Organizing Scientific Research for War. Boston: Little, Brown and Co., 1948.
- Stilian, Gabriel N. PERT. A New Management Planning and Control Technique. New York: American Management Assn., 1962.
- Thiesmeyer, L. R. and Burchard, J. E. Combat Scientists. Boston: Little, Brown and Co., 1947.

Turabian, Kate L. A Manual for Writers of Term Papers, Theses and Dissertations. Chicago: The University of Chicago Press, 1955.

US, Army Ordnance Department. Sketches of the Ordnance Research and Development Center in World War II. Aberdeen, Md.: Aberdeen Proving Ground, 25 February 1947.

Wiesner, Jerome B. Where Science and Politics Meet. New York: McGraw-Hill Book Co., 1965.

Wilkinson, Henry M., R. A. S. Engines of War. London: Longman, Orme, Brown, Green and Longman, 1841.

Articles and Periodicals

Ackoff, Russell Lincoln. "The Development of Operations Research as a Science," Operations Research, Vol. 4, 1956, pp. 265-295.

Hitch, Charles. "Comments," Operations Research, August 1956.

Kittel, Charles. "The Nature and Development of Operations Research," Science, 7 February 1947.

Koopman, Charles O. "Fallacies in Operations Research," Operations Research, August 1956.

Mooney, Craig M. "Operational Research, A Deciding Military Science," Canadian Business, July 1954.

Norton, N. W. "A Brief History of the Development of Canadian Military Operational Research," Operations Research, Vol. 4, 1956, pp. 187-192.

Ortlieb, E. J., CMDR, USN. "Defense Systems Analysis Program," United States Naval Institute Proceedings, August 1966, pp. 148-150.

Stillman, Richard J. "The Pentagon's Whiz Kids," United States Naval Institute Proceedings, April 1966, pp. 52-60.

Ways, Max. "The Road to 1977," Fortune, Vol. LXXV, No. 1, January 1967, pp. 93-95, 194-200.

Reports

Center for Research in Social Systems. Work Program Fiscal Year 1967. Washington, D.C.: Center for Research in Social Systems, The American University, 1 August 1966.

Freeman, Raoul J. Developments for Modern Management. Memo. P-3210. Santa Monica, Calif.: Rand Corp., August 1965.

General Research Office. General Research Office Quarterly Report.
Vol. 1, No. 1. Washington, D. C.: General Research Office, The
Johns Hopkins University, 30 September 1948.

Gibb, Fredrick W., BG, USA. The US Army Combat Development Experimenta-
tion Center. Ft. Ord, Calif.: U.S. Army Combat Development Ex-
perimentation Center, 18 February 1957.

Hitch, Charles. An Appreciation of Systems Analysis. P-699 (revised).
Santa Monica, Calif.: Rand Corp., 18 August 1955.

_____. Economics and Military Operations Research. P-1250. Santa
Monica, Calif.: Rand Corp., 8 January 1958.

Human Resources Research Office. Bibliography of Publications as of 30
June 1966. Alexandria, Va.: Human Resources Research Office,
The George Washington University, September 1966.

_____. What HUMRRO is Doing. Washington, D.C.: Human Resources Re-
search Office, HUMRRO Research Bulletin No. 1, The George Wash-
ington University, March 1954.

_____. What HUMRRO is Doing. Washington, D.C.: Human Resources Re-
search Office, HUMRRO Research Bulletin No. 2, The George Wash-
ington University, April 1955.

_____. What HUMRRO is Doing 1955. Washington, D.C.: Human Resources
Research Office, HUMRRO Research Bulletin No. 3, The George Wash-
ington University, April 1956.

_____. What HUMRRO is Doing Jan 56--Jun 57. Washington, D. C.:
Human Resources Research Office, HUMRRO Research Bulletin No. 4,
The George Washington University, December 1957.

_____. What HUMRRO is Doing Jul 57--Jun 58. Washington, D.C.: Human
Resources Research Office, HUMRRO Research Bulletin No. 5, The
George Washington University, December 1958.

_____. What HUMRRO is Doing Jul 59--Jun 60. Washington, D.C.: Human
Resources Research Office, HUMRRO Research Bulletin No. 7, The
George Washington University, April 1961.

_____. What HUMRRO is Doing Jul 61--Jun 62. Washington, D.C.: Human
Resources Research Office, HUMRRO Research Bulletin No. 9, The
George Washington University, September 1962.

Kahn, H. and Mann, I. Techniques of Systems Analysis. RM 1829-1 (rev).
Santa Monica, Calif.: Rand Corp., 3 December 1956, revised June
1957.

_____. Ten Common Pitfalls. RM-1937. Santa Monica, Calif.: Rand
Corp., 17 July 1957.

Kent, A. I. Non-Military Applications of Operations Research. P-526. Santa Monica, Calif.: Rand Corp., 14 May 1954.

Laugham, Harauld D., LTC. Historical Summary, United States Army Combat Developments Command Experimentation Center, 1 Nov 1956--30 Jun 1964. Ft. Ord, Calif.: U. S. Army Combat Developments Command Experimentation Center.

Milton, Helen S. Army Operations Research--FY 62. Bethesda, Md.: Research Analysis Corp., February 1963.

_____. Cost-of-Research Index, 1920-1965. RAC-TP-209. McLean, Va.: Research Analysis Corp., March 1966.

_____ and Johnson, Ellis A. Sponsorship of Research: A Survey of Scientific Literature, 1920-1960. ORO-TP-42. Bethesda, Md.: Operations Research Office, The Johns Hopkins University, September 1961.

Operations Research Office. Operations Research Office Quarterly Report, Vol. 1, No. 1. Washington, D.C.: Operations Research Office, The Johns Hopkins University, 31 December 1948.

_____. Operations Research Office Quarterly Report. Vol. II, No. 1 & 2. Washington, D.C.: Operations Research Office, The Johns Hopkins University, 30 June 1949.

_____. ORO Today. Chevy Chase, Md.: Operations Research Office, The Johns Hopkins University, January 1955.

_____. Publications and Briefings for the Army. Bethesda, Md.: Operations Research Office, The Johns Hopkins University, May 1959.

Pettee, George S. The Decision-Making Problems of the Army. ORO-SP-40. Bethesda, Md.: Operations Research Office, The Johns Hopkins University, December 1957.

Quade, E. S. Military Analysis. Memo. RM 4808 PR. Santa Monica, Calif.: Rand Corp., November 1965.

_____. Military Systems Analysis. Memo. RM 3452. Santa Monica, Calif.: Rand Corp., January 1963.

Report of the Gun Foundry Board--1884. Washington, D.C.: Government Printing Office, 1884.

Research Analysis Corporation. Research Analysis Corporation WY 64 Work Program, 1 Sep 1963--31 Aug 1964. Bethesda, Md.: Research Analysis Corp., September 1963.

_____. Scientific Problem Solving. Bethesda, Md.: Research Analysis Corp., undated.

Rumbaugh, Lynn H. A Look at US Army Operations Research--Past and Present. RAC-TP-102. Paper prepared for the Eighth ABCA Discussions on Operational Research, Washington, D. C., June 1963. McLean, Va.: Research Analysis Corp., April 1964.

Seldes, George (ed.). The Great Quotations. Lyle Stuart, N.Y.: A Caesar-Stuart Book, 1960.

Smith, Nicholas M. Operations Research in the Next 20 Years: A Technological Forecast. RAC-TP-103. Paper prepared for the Eighth ABCA Discussions on Army Operational Research, Washington, D.C., June 1963. McLean, Va.: Research Analysis Corp., January 1964.

Special Operations Research Office, SORO R&D Work Program FY 65. Washington, D.C.: Special Operations Research Office, The American University, July 1964.

Stoller, David S. Reliability Science and Technology in Military and Industrial Contexts. P-2802. Santa Monica, Calif.: Rand Corp., October 1963.

US Army Combat Developments Command, Activation Plan. Vols. I & II. Ft. Belvoir, Va.: Combat Developments Command Planning Group, 1 June 1962.

_____. Organization and Functions. USACDC Pamphlet No. 10-2. Ft. Belvoir, Va.: US Army Combat Developments Command, September 1966.

US Army Command and General Staff College. Instructional Packet for Common Subjects Modern Analytical Methods (Operations Research/Systems Analysis. Ft. Leavenworth, Ks.: US Army Command and General Staff College, April 1967.

US Army Logistics Management Center. Logistics Study Program of the Deputy Chief of Staff for Logistics and the U.S. Army Materiel Command. Ft. Lee, Va.: U.S. Army Logistics Management Center, 31 May 1966 and 1 August 1966.

US Army Materiel Command. Activation Plan. Washington, D.C.: U.S. Army Materiel Command, 16 July 1962.

_____. The First Year. Washington, D.C.: U.S. Army Materiel Command, October 1963.

_____. Organization and Functions Manual. Washington, D.C.: U.S. Army Materiel Command, 16 November 1964.

US Army Research Office. Fiscal Year 1961 Army Research Task Summary. Vol. 6. Durham, N.C.: US. Army Research Office, 1961.

_____. Research in Progress 1961. Durham, N.C.: U.S. Army Research Office, 1961.

- _____. Technological Forecast 1961. Vol. 1. Washington, D.C.: U.S. Army Research Office, 1961.
- _____. U.S. Army Operations Research Symposium Proceedings 1962. Part I. Durham, N.C.: US Army Research Office, March 1962.
- _____. U.S. Army Operations Research Symposium Proceedings 1964. Part I. Durham, N.C.: U.S. Army Research Office, May 1964.
- US Defense Documentation Center. Operations Research (supplement) A Report Bibliography. Cameron Station, Alexandria, Va.: Defense Documentation Center, January 1964.
- US Department of the Army. Organization for the Foreign Science and Technology Center, Army Materiel Command. Washington, D.C.: Office, Assistant Chief of Staff, Intelligence, 9 July 1962.
- _____. Report of the Department of the Army Board to Review Army Officer Schools. Vol. III. Washington, D.C.: Department of the Army, February 1966.
- _____. Reorganization of the Office Chief of Staff. CS 320. Washington, D.C.: Office of the Chief of Staff, Memorandum from the Chief of Staff for the Heads of Staff Agencies, 16 February 1967.
- _____. Strategy and Tactics Analysis Group (STAG). Briefings for the Department of the Army Staff on 23-24 October 1961, Part I, Narrative. Washington, D.C.: October 1961.
- _____. US Army Organization and Procedures for Research and Development. Washington, D.C.: Office of the Chief of Research and Development, January 1959, revised May 1961, revised September 1962.
- US Research and Development Board. Committee on Human Resources. Washington, D.C.: Research and Development Board Directive, 28 March 1948.
- US War Department. Annual Report of the Army Service Forces for the Fiscal Year 1943. A Report to the Under Secretary of War and the Chief of Staff by the Director of the Service, Supply and Procurement Division, War Department General Staff. Washington, D.C.: 15 August 1943.
- _____. Annual Report of the Army Service Forces for the Fiscal Year 1945. A Report to the Under Secretary of War and the Chief of Staff by the Director of the Service, Supply and Procurement Division, War Department General Staff. Washington, D.C.: 10 November 1947.
- _____. Logistics in World War II--Final Report of the Army Service Forces. A Report to the Under Secretary of the Army and the Chief of Staff by the Director of the Service, Supply and Procurement Division, War Department General Staff, Washington, D.C.: 1 July 1947.

Williams, Richard Hays (ed.). Human Factors in Military Operations.
 ORO-T-259. Chevy Chase, Md.: Operations Research Office, The
 Johns Hopkins University, 7 January 1954.

Yahraes, Herbert. ORO--A Record of its Work (U). Bethesda, Md.: Oper-
 ations Research Office, The Johns Hopkins University, July 1961.

Young, John P. A Survey of Historical Developments in War Games (U).
 ORO-SP-98. Bethesda, Md.: Operations Research Office, The Johns
 Hopkins University, March 1959.

Unpublished Material

US Army Field Forces. Transmission of Periodic Reports from AFF Human
 Research Units. Letter, ATDEV-8 319.1, from Office of Chief of
 Field Forces, Ft. Monroe, Va., to Commandant C&GSC, Ft. Leaven-
 worth, Ks., 17 December 1952.

US Department of the Army. Establishment of a Scientific Research Unit
 to Study Problems of Training. Letter, AGAOI 353 (20 Aug 51)
 G4-M, from the Office of the Adjutant General Department of the
 Army to the Chief of Army Field Forces, Ft. Monroe, Va. Wash-
 ington, D.C.: 27 August 1951.

. Establishment of a Scientific Research Unit to Study Problems
 in Motivation, Morale and Leadership. Letter, G4/F2 2696 from
 the Office of the Assistant Chief of Staff, G-4, Logistics, to
 the Chief of Army Field Forces, ATTN: R&D Section, Ft. Monroe,
 Va. Washington, D.C.: 27 January 1952.

. U.S. Army Research and Development Organization. Prepared by
 Programs and Budget Division, Office of the Chief of Research and
 Development. Washington, D.C.: 1 April 1967 (presently being
 prepared but not printed).



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REPLY TO
ATTENTION OF:

ATZL-SWY

30 September 2004

MEMORANDUM FOR ATTN: Larry Downing, DTIC-ACQ, Defense Technical Information Center, 8725 John J. Kingman Road, Suite 0944, Fort Belvoir, VA 22060-6218

SUBJECT: Change in Distribution

1. Request a distribution statement change to the following documents:

ADB954487, Smith, F. L., "History of The U.S. Army in Operations Research.", dated 1967.

2. The distribution statement change, effective 30 September 2004 per Dr. Roger Spiller, Marshall Chair, US Army Command and General Staff College, subject matter expert and Reviewer, should read the following: (A) Approved for public release: Distribution unlimited.

3. POC for this request is Rusty Rafferty or John Rogers, Reference Librarians Classified Documents Section, DSN 585-3128 or COM 913-758-3128 or FAX: DSN 585-3014 or COM 913-758-3014.

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